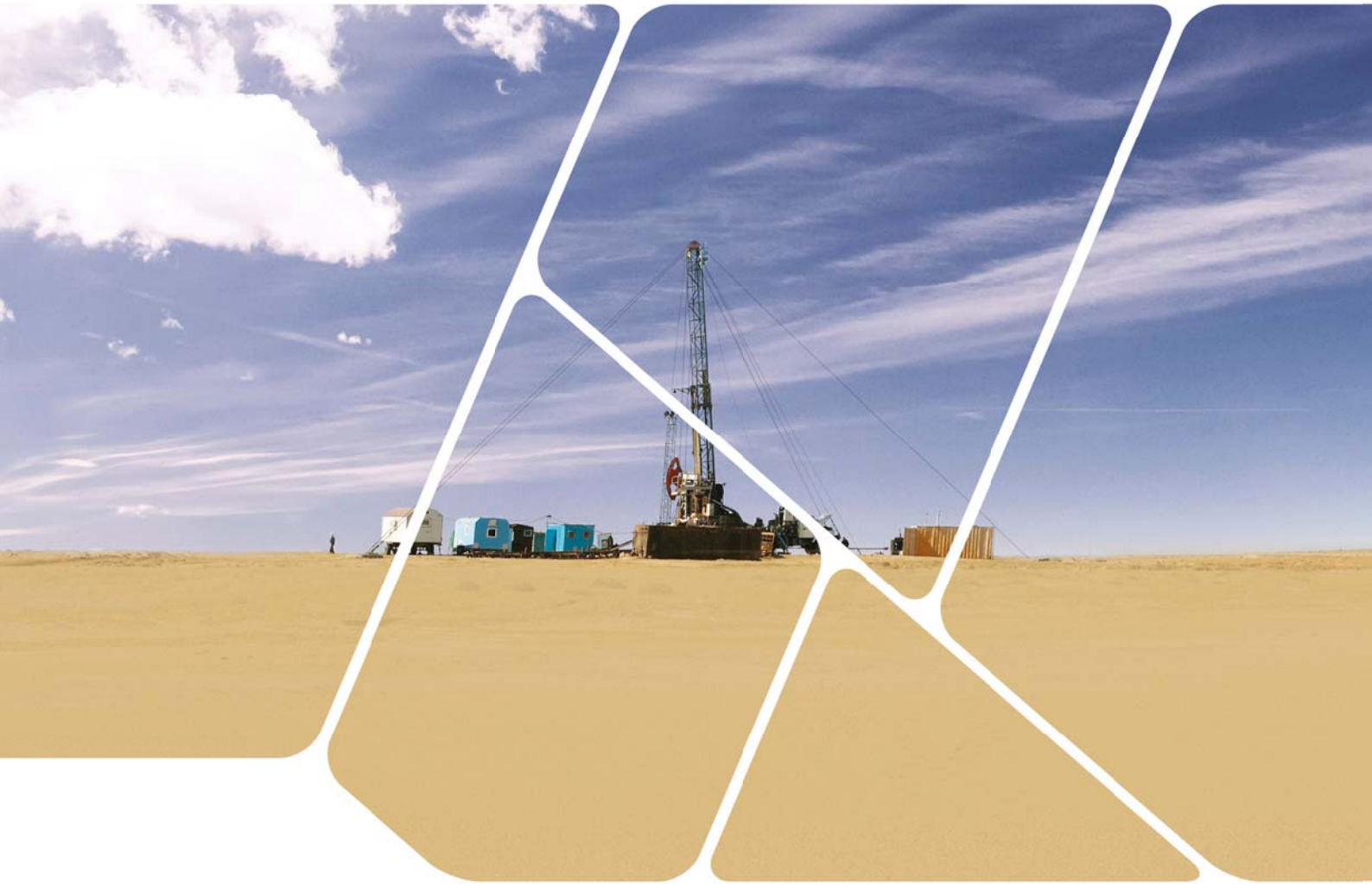


W8 : Project Management

Formation certifiante en Management de la chaine de valeur de l'EP et Ingénierie pétrolière – *Du 05 Février au 09 Février 2017*



Project Management

Application to Oil & Gas upstream projects

IFP Training

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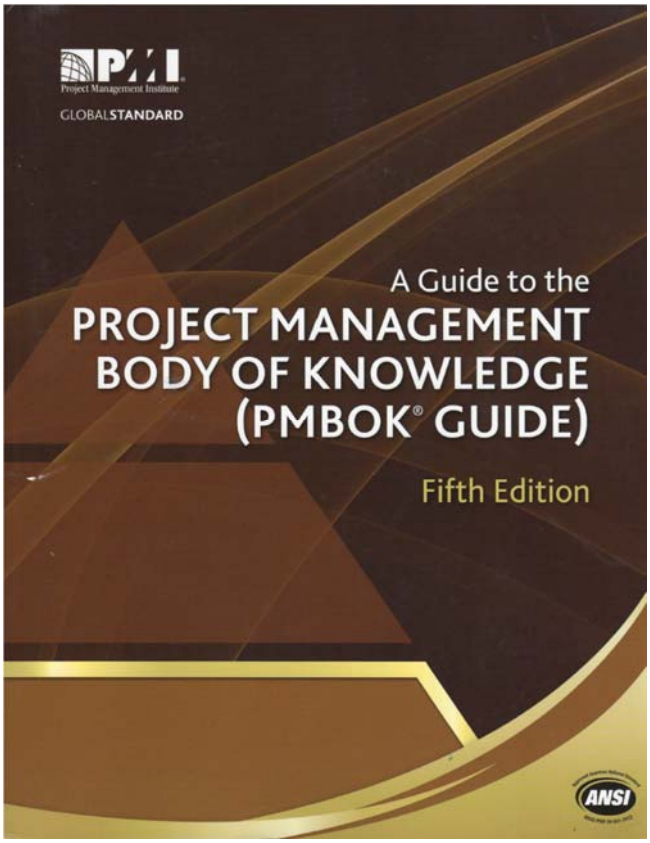
Project Management Processes

The need of process groups

- **Enforcing process groups is a proven technique to help Projects meet their objectives**
- **Process groups help balancing the competing constraints of**
  - Scope
  - Schedule
  - Budget
  - Quality
  - Safety and environmental protection
- **As such, they contribute to make sucessful Projects**

An international reference

- The Project Management Institute is considered a leading international reference for the project management profession
- Since 1969, this non-profit association based in the USA has set rules, standards and definitions commonly applied in divers fields of industry, specially the Oil & Gas business
- Their knowledge is gathered in the PMBOK® guide, used as a reference throughout this course

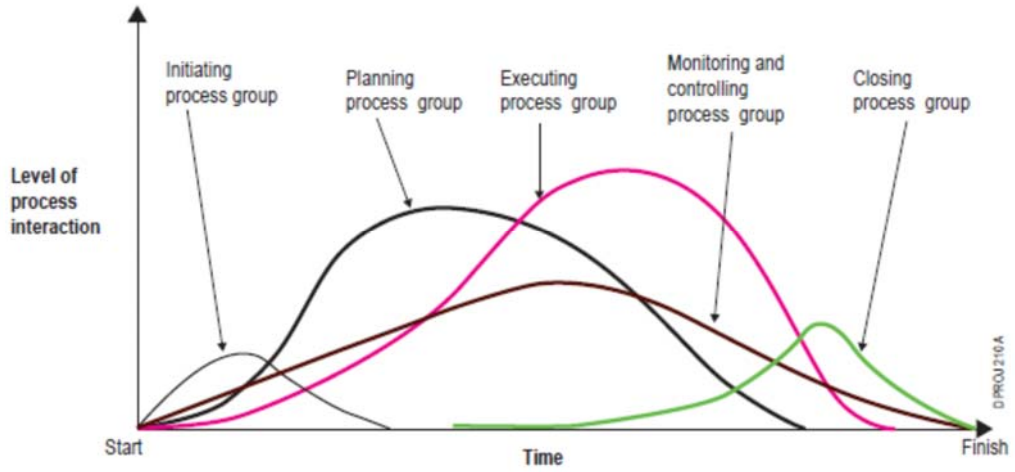


PMI's five process groups

- Initiating process group
- Planning process group
- Executing process group
- Monitoring and controlling process group
- Closing process group

Process groups

- Project management process groups are sets of interrelated actions and activities to create a specific result
- All such processes overlap, interact and their application is iterative



- Process groups are not project lifecycle phases

Initiating process group

Objectives

- Define initial scope for a project or new phase of a project by obtaining authorization to start the project or phase
- Align stakeholders expectations with the project objectives
- Set the vision of the project

Inputs

- Project Basis of Design
- Business agreements

Outputs

- Project charter/scope/Organization
- Stakeholder register

Planning process group

Objectives

- Define and refine objectives. Develop course of action to achieve these objectives
- Develop Project Management Plan and project documents to carry out the work
- Delineate strategy and tactics to achieve the objectives
- Get stakeholders engagement

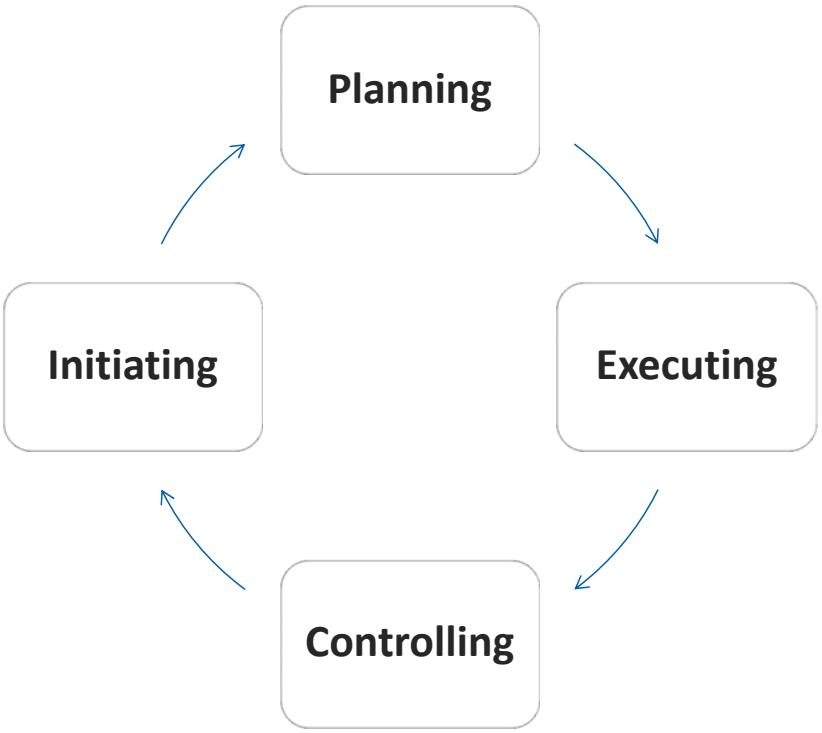
Inputs

- Outputs from initiating project group

Outputs

- Plans and project documents
- Develop risk register and risk management plan

Planning is an iterative process



For complex projects, several loops may be required for additional analysis – progressive elaboration

As more information is generated, additional planning may be required

Stakeholders to be kept in the revision loop

Competing project constraints



Executing process group

Objectives

- Integrate and perform activities in accordance with the Project Management Plan
- Coordinate people and resources
- Maintain stakeholders engagement

Inputs

- Project Management Plan

Outputs

- Project deliverables
- Project records

Monitoring and controlling process group

Objectives

- Continuous tracking and reviewing of progress and performance of the project
- Implement corrective or preventive measures to comply with the Project Management Plan

Inputs

- Work performance data
- Change requests
- Deliverables

Outputs

- Approved change requests
- Quality control measurements
- Work performance information and reports

Closing process group

Objectives

- Processes to formally conclude the project or project phase

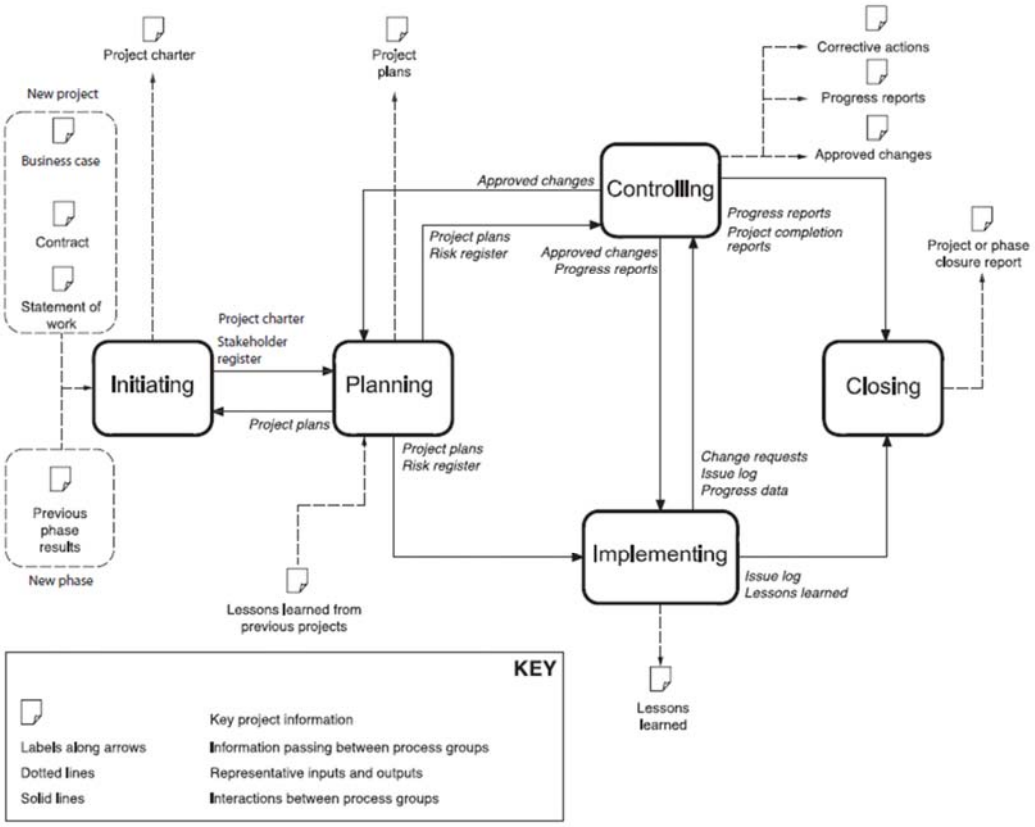
Inputs

- Results of all previous process groups

Outputs

- Close out reports
- Formal documentation and certificates
- Contractual obligations closure (financial or warranty claims)
- Hand over procedures or certificates

Interactions between the processes



Knowledge areas

- **PMI has defined 10 knowledge areas**
  - Integration management
  - Scope management
  - Time management
  - Cost management
  - Quality management
  - Human resources management
  - Communication management
  - Risk management
  - Procurement management
  - Stakeholder management
- **Process groups apply to each of these**
- **For the purpose of this course, five additional areas, specific to O&G project activities, have been added:**
  - HSE management
  - Management of collective knowledge
  - Engineering management
  - Construction management
  - Commissioning and start up management
- **This constitutes the Project Management Breakdown Structure**

Management processes

- **Management processes detail how the activities are to be conducted**

Knowledge areas	PROJECT MANAGEMENT PROCESS GROUP				
	Initiating process group	Planning process group	Executing process group	Monitoring and controlling process group	Closing process group
4 Project integration management	4.1 Develop project charter	4.2 Develop project management plan	4.3 Direct and management work project	4.4 Monitor and control project work 4.5 Perform integrated charge control	4.6 Close project or phase

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- **Each of them can be documented with:**
  - Inputs
  - Tools and Techniques
  - Ouputs



Scope

Foreword

Main objective

- Define project scope in detail

Main tools and means

- Evaluation studies to be select the right development concept
- Identification the different steps to carry and meet the pre-requisites of each of them
- Validation and approval by the Project Management team



Scope

- Project Scope Management during Evaluation phase

Project Scope Management during Evaluation phase

Plan pre-sanction activities

- **Determine the objective and content of pre-sanction studies and sequence of execution**

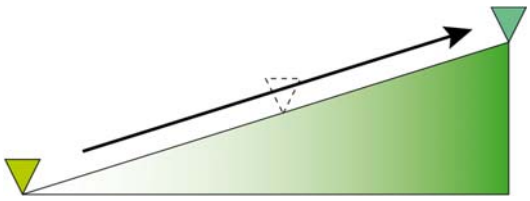
Collect input data and requirements

Perform pre-sanction sequence of studies

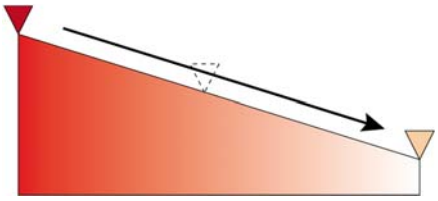
Validate concept retained for project

Objectives of pre-sanction activities

Confirm knowledge



Reduce risks

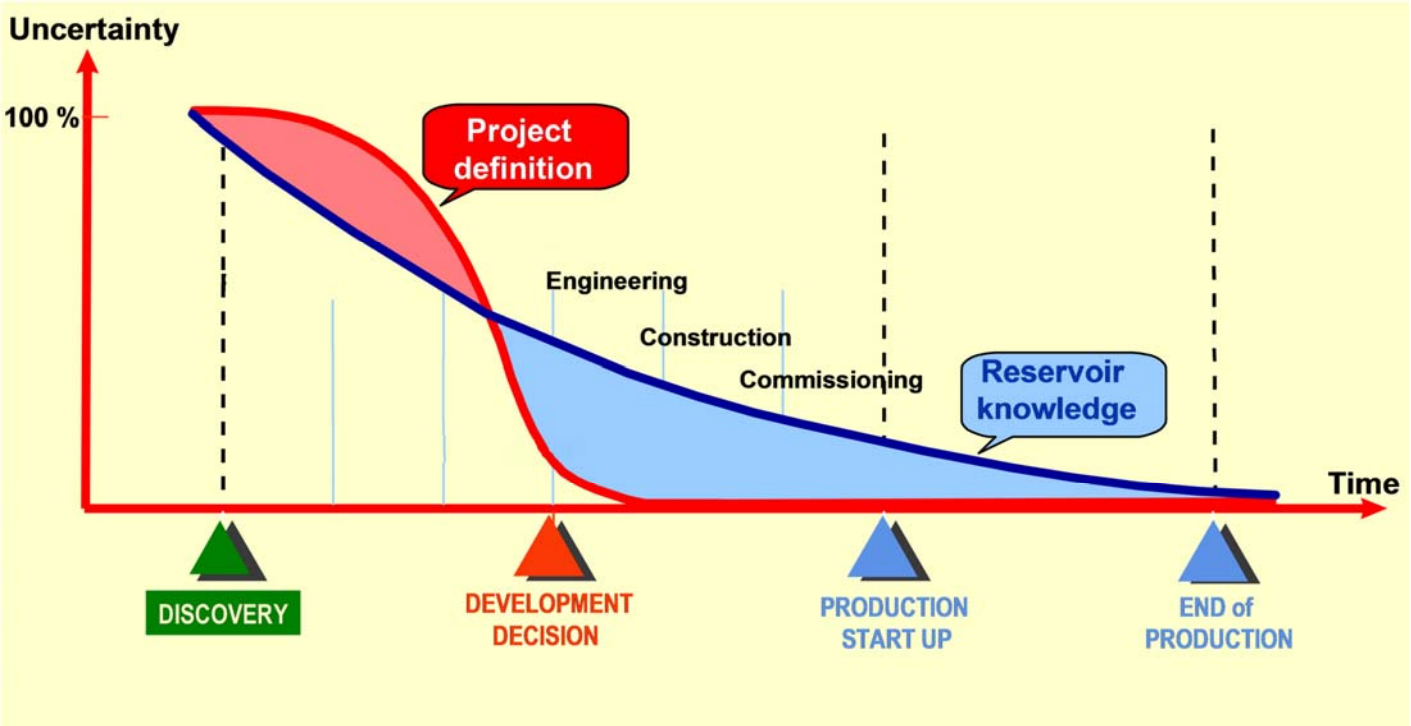


Appraisal
Development schemes and concept
Budget and schedule
Execution principles

Dossier for Project decision to move to next phase

Note: Exploration, Discovery are performed separately, and prior to project

Risk and uncertainties *vs.* time



Project scope management process

Appraise Development Potential

Select Best Concept for Development

Develop Concept

Preliminary Study

Remaining appraisal requirements
Preliminary scheme
Technical feasibility
Prelim. Schedule & cost estimates

Conceptual Study

Screening of alternatives
Confirmation of feasibility
Key parameters definition
Concept selection

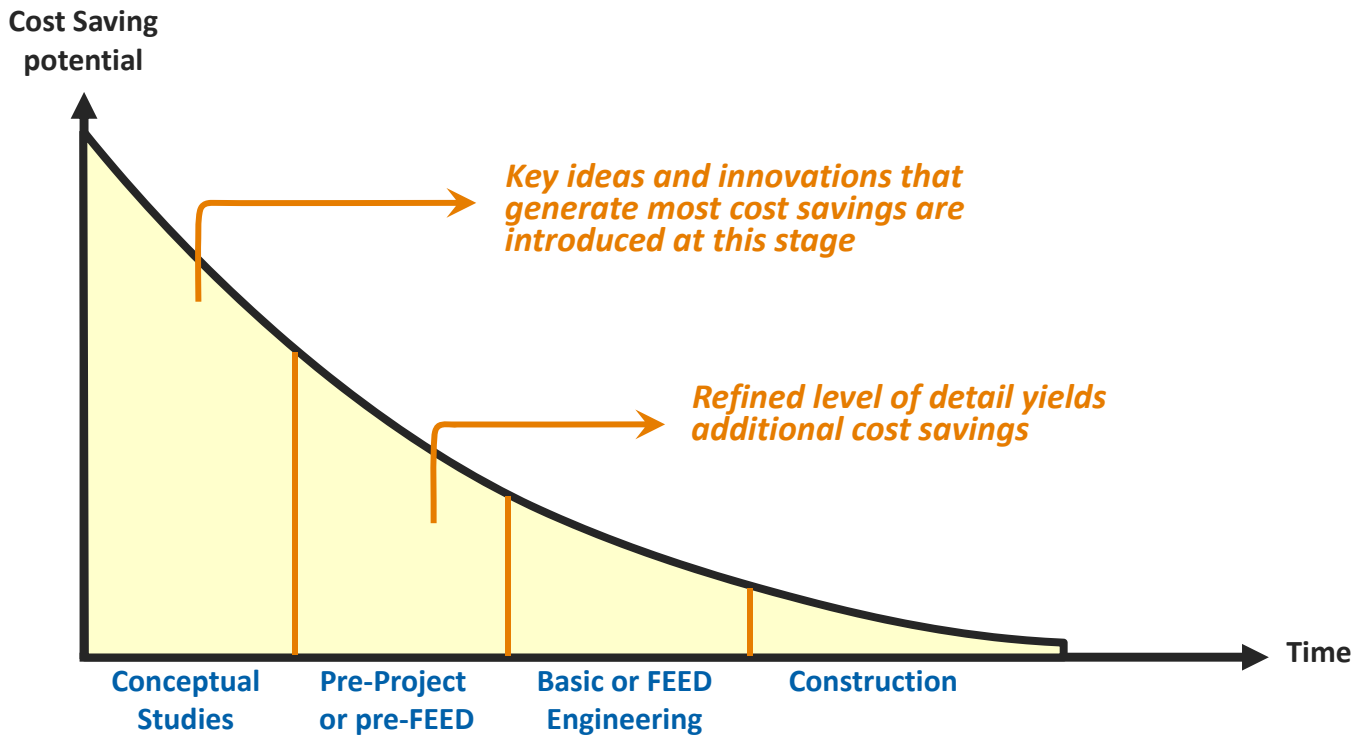
Pre-project (pre-FEED) Study

Detailed evaluation of selected concept
Basis of design/SOR
Field/plant development plan
Project execution principles
Project execution Estimate
Project execution Schedule
Project economics

BASIC or FEED + EPC PHASE

Implementation and execution of all that has preceded, up to first oil or first gas

Major cost savings opportunities are at early stages



Project Scope Management during Evaluation phase

Plan pre-sanction activities

Collect input data and requirements

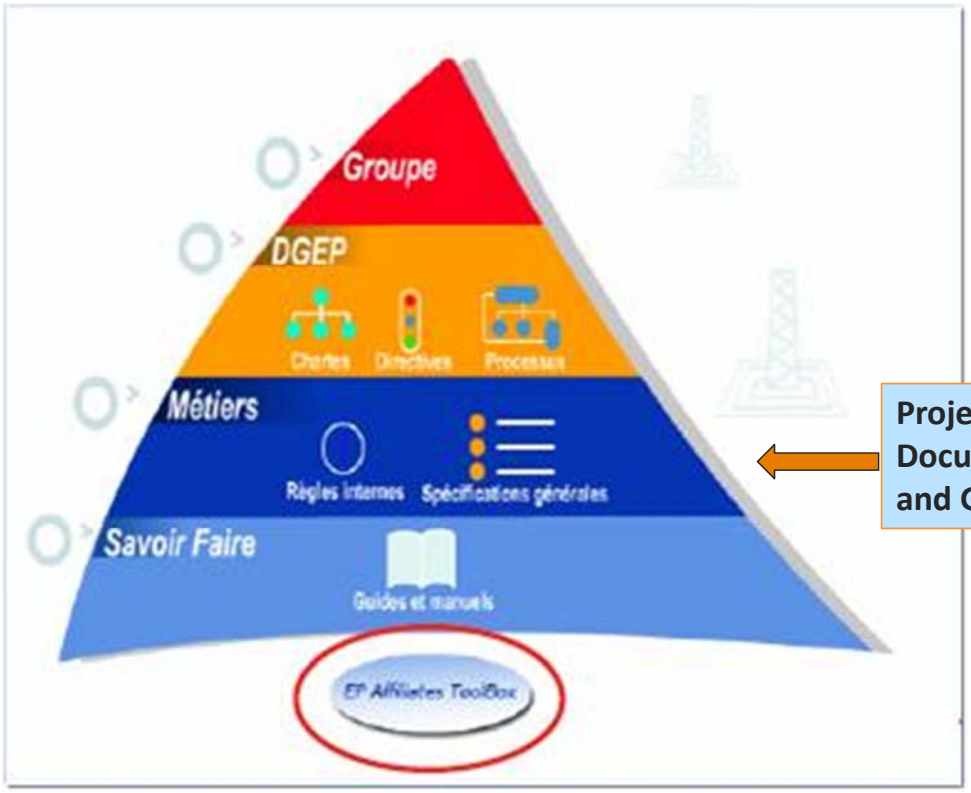
- Define applicable international or national rules and regulations
- Define corporate requirements
- Define stakeholders' requirements (communication and Local content)
- Collect lessons learnt from similar projects
- Identify new technologies applicable to the project

Perform pre-sanction sequence of studies

Validate concept retained for project

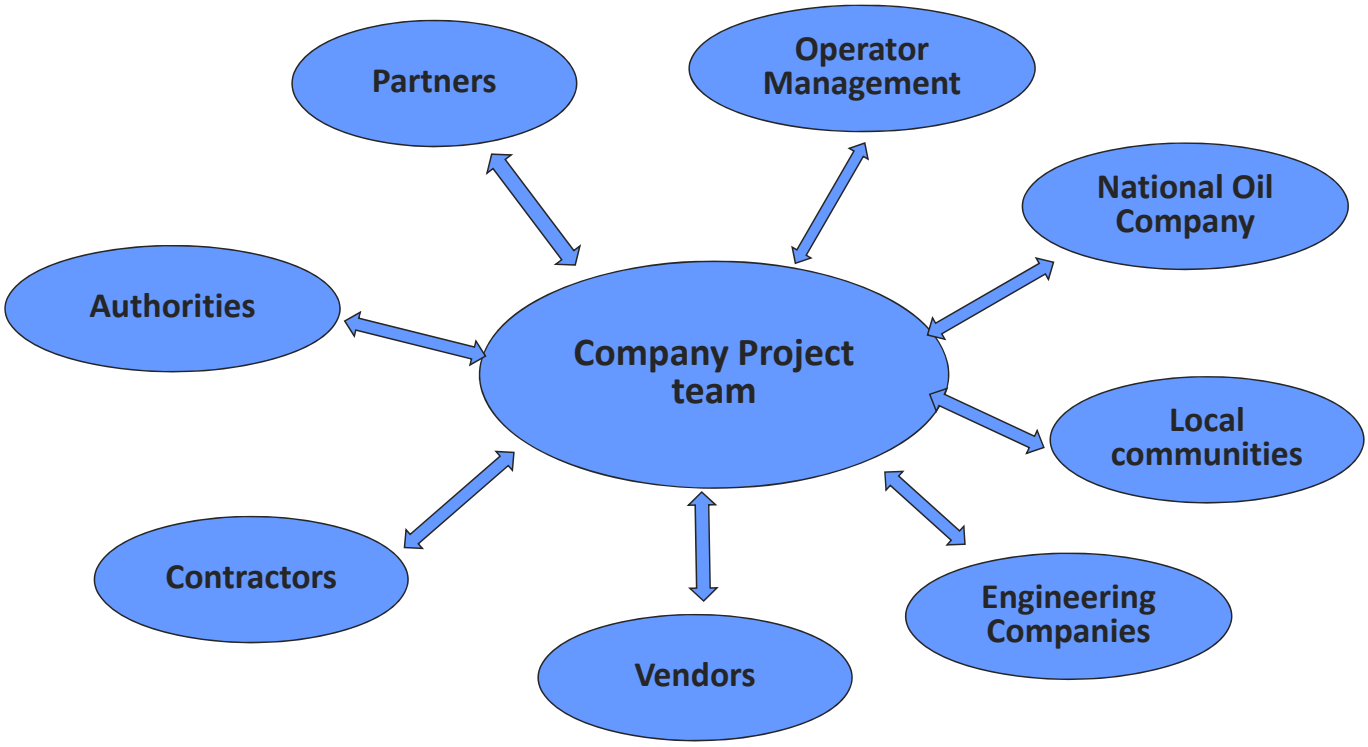
Company referential

Company Documentation



Project technical reference Documents are Internal rules and General specifications

Project Stakeholders



Project Scope Management during Evaluation phase

- Plan pre-sanction activities
- Collect input data and requirements
- Perform pre-sanction sequence of studies
  - Preliminary studies
  - Conceptual studies
  - Pre-FEED
  - FEED or Basic Engineering studies
- Validate concept retained for project
- Sanction the Project

Preliminary studies

- **Objective:**
  - Verify in a simplified way that the field can be developed in an economic way
- **Method highlights**
  - Refer to past experience and find an analog in terms of development
  - Alternatively use a specialized software to define OOM cost and schedule
  - Evaluation Criteria:
    - Order of Magnitude Costs
    - Schedule
    - Preliminary economic calculations
    - Safety & Environmental issues
    - Risks (technical, economic)
    - Stakeholders, partners & authorities requirements

Conceptual studies

- **Objective:**
  - Select the best scheme for field development and production
- **Method highlights**
  - List the possible schemes/concepts/scenarii to be studied, based on:
    - Overall knowledge of the development area specific requirements
    - Common sense
    - Brainstorming
    - Analogue, previous experience
  - Two-step analysis
    1. "Screening" cases
    2. Detailed analysis of the shortlisted cases
  - Concept selection Criteria:
    - Value creation
    - Costs
    - Risks (technical, economic)
    - Experience, operability, flexibility
    - Technical innovations
    - Safety & environment
    - Stakeholders, partners & authorities
    - Local content requirements

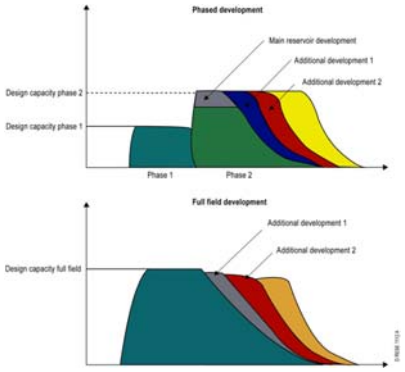
Conceptual studies

Main technical options

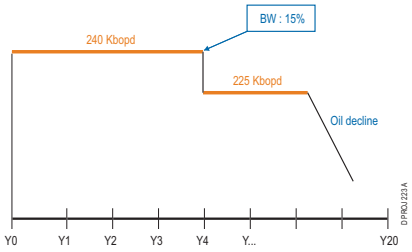
- **When planning an O&G development project, the following questions should be addressed:**
  - Reservoir depletion strategy
    - Natural depletion?
    - Water or gas injection to maintain reservoir pressure? Artificial lift?
    - Production profile (plateau level and duration)
    - Phased development?
  - Wells
    - Completion strategy
    - Wells trajectories
    - Surface or subsea wells or both?
    - Pre-drilling? Type of rig
  - Production/treatment
    - Fluid treatments
    - Safety: field/plant layout, grouping or separation of functions
    - Export: standalone or tie-in to existing export system?
  - Construction strategy
    - Construction yards/support availability in the area
    - Project execution schedule
    - Contracting strategy

Example of conceptual selection studies

Phasing options



Size optimization



Field architecture

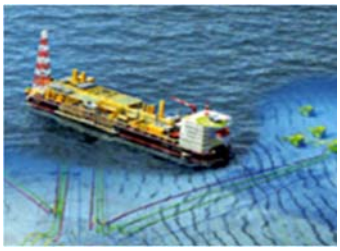


Development concept 1: central drilling and processing facility with additional subsea wells



Development concept 2: full subsea development with single processing platform

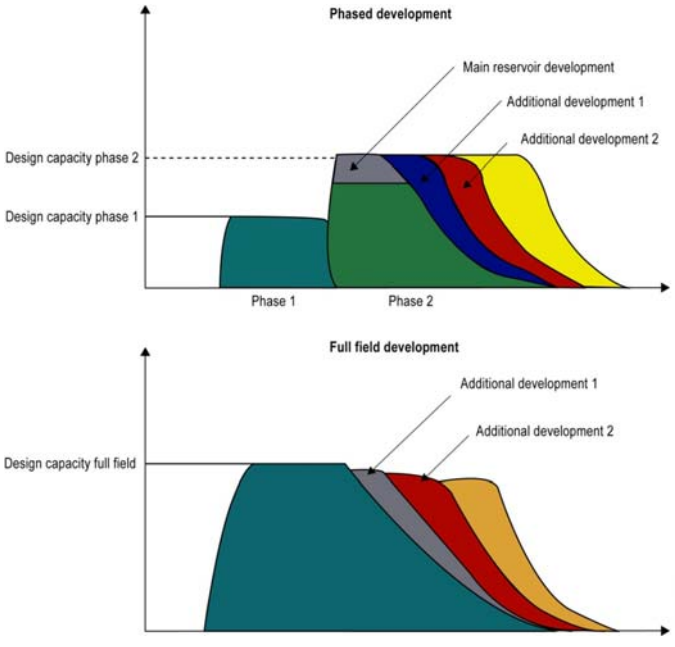
Technology options





Example of conceptual selection studies

Phasing options



- **Phased approach**
  - Advantages: provides dynamic appraisal of the field, reduces upfront CAPEX
  - Disadvantages: generally reduces project economics, longer development period
- **Full Field approach**
  - Advantages: early and higher production level, shorter development period
  - Disadvantages: higher level of uncertainty on reservoir behaviour
- **Comparison criteria**
  - Reservoir uncertainties
  - Company CAPEX position
  - Economics

Example of conceptual selection studies

Field architecture options

- **Options investigated (Full Field option)**
  - Full subsea with FPSO
  - Full subsea with subsea boosting
  - One single surface wellhead platform
  - One main wellhead platform with two wellhead satellite platforms
  - One main Wellhead platform with subsea wells
- **Comparison criteria**
  - Production profile
  - Wells feasibility
  - Reliability, Availability, Maintainability
  - Costs (wells and facilities)
  - Planning
  - Risks assessment
  - HSE particular considerations



Development concept 1: central drilling and processing facility with additional subsea wells

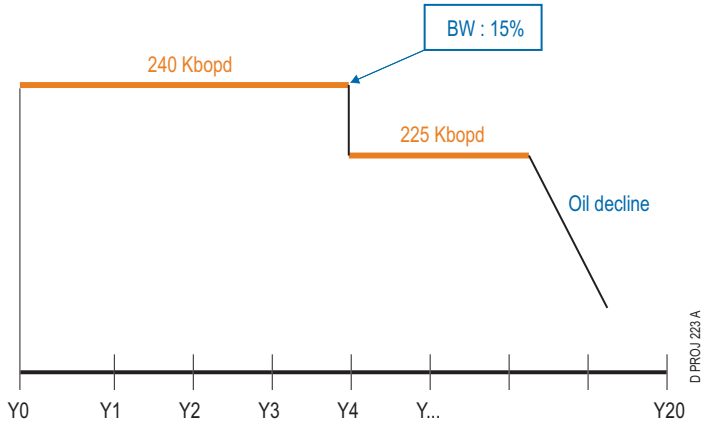


Development concept 2: full subsea development with single processing platform

Example of conceptual selection studies

Size optimization

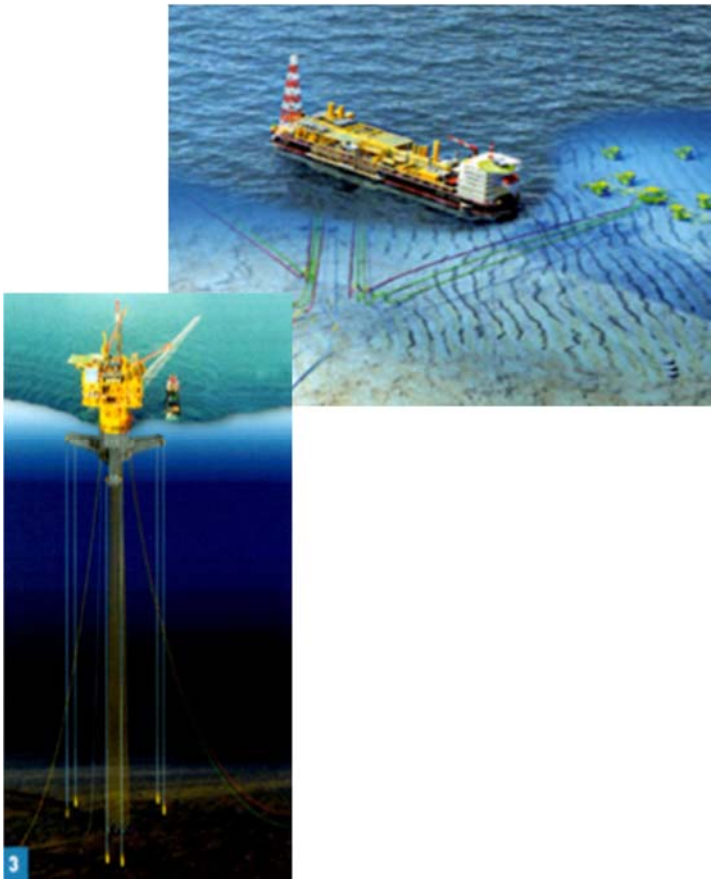
- **Objective:**
  - To define a production profile that is optimized from a technical and economical point of view
- **Parameters to be considered**
  - Production profile
  - Wells characteristics
- **Parameters to be optimized**
  - Liquid treatment capacity
  - Oil plateau rate
  - Plateau duration
  - Facilities sizing (step change effect on some equipment)



Example of conceptual selection studies

Technology options

- **Support options**
  - FPSO
  - Subsea technologies
  - Multi Functional Barge (MFB) or PDQ
  - SPAR concepts
  - Other concepts
- **Selection criteria**
  - Feasibility
  - Development level
  - Risk assessment
  - RAM
  - Cost
  - Schedule
  - Contracting strategies



Conceptual studies

Content for each scheme

- **Reservoir Development Plan***
- **Technology (type, size selections)**
- **Material balances**
- **Well description***
- **PFDs, Block diagram**
- **Surface facilities description**
- **Site selection study**
- **Main equipment list**
- **Preliminary simplified layouts**
- **Simplified Operating philosophy**
- **Preliminary Safety concept (including Hazid)**
- **Preliminary construction principles**
- **Preliminary development schedule**
- **Costs estimate (Capex & Opex)**
- **Economic evaluation**

Nota *: if applicable

Pre-project studies

Also called Project definition studies or pre-FEED

- **Objectives:**
  - Study in more detail the development scheme recommended at the end of the conceptual studies.
  - Define the costs and execution schedule of the selected solution with sufficient robustness.
  - Present how the project will be executed during next (FEED or BASIC, EPC) phases and the execution strategy approach and options.
  - Establish « Basis of Design or Statement of Requirements » which will be the reference document for the whole Project phase,
  - Specify the Project « referential »
  - Assess remaining risks and their potential impact for the execution of the Project as well as during the life of the field/plant.
- **The pre-project will allow project to move forward towards Project's sanction**
  - Launch FEED or BASIC

Project Scope Management

during Evaluation phase

Plan pre-sanction activities

Collect input data and requirements

Perform pre-sanction sequence of studies

Validate concept retained for project

- **Validating design results**
- **Formalize design parameters through SOR**
- **Getting stakeholders technical approval of the recommended solution**

Proposal for owner internal validation process

	Apraisal	Pre-Project	Basic engineering	Detailed engineering	Fabrication & construction	Commissioning	Handover to Production
Main documents	Apraisal report Valuation report Feasibility report	Project Development Plan Statement of Requirements Reservoir Mngt Plan Drilling Program	FID Dossier Project Execution Plan Project Procedures Updates of all dossiers issued from pre-Project	Equipment dossiers Materials Construction drawings Commissioning Dossier	As-built Dossier	Commissioning Dossier completed	Close out Report
Project Committees	Geosciences	Risks, Finance, Technical etc	EP, COMEX	Project reviews	Project reviews	Project reviews	Project reviews
Partner inputs	According contracts	According contracts	According contracts	According contracts	According contracts	According contracts	According contracts
Validation (Gate Process)	Approve feasibility study	Approve developpement plan	FID approval			Operations acceptance	Overall performance
Technical reviews	Yes	Yes	Yes	Yes	Yes	Yes	
Quality reviews	Review	Review	Review, audits	Review, audits	Review, audits	Review, audits	Review, audits
Satey reviews		Hazop, Hazid, Hazan, PRA	Hazop, Hazid, Hazan, PI&D review, QRA	Hazop, Safety dossier update			Safety dossier final issue

Statement of Requirements

- **SOR records and maintain up to date key parameters of the project**
- **SOR will be used to check that the project remains in line with the Corporate organization requirements, and record main changes agreed during the project execution.**
- **SOR will be updated at key steps during the course of the project:**
  - Initial SOR established when starting the preliminary evaluation studies (Owner)
  - Updated prior to starting the project execution phase: detailed engineering, procurement, construction, installation when technical content of the project defined and execution strategy firmed up (Owner or Contractor)
- **Signed by high level responsible persons in the owner or contractor organization to ensure that all parties have understood and agreed upon the fundamental choices pertaining to the project or project phase.**

Project SOR content

- **Project purpose or justification**
- **Measurable project objectives and related success criteria**
- **High level (host country and Company) requirements**
- **Assumptions and constraints**
- **High level project description and boundaries**
- **High level risks**
- **Summary milestones schedule**
- **Summary budget**
- **List of stakeholders**
- **Project approval requirements**
- **Responsibility and authority of the Project Manager**

Definition of Project objectives

1. **HSE**
   - Respect and protect the local socio-economic environment and communities
   - Minimize impact and maintain risks to acceptable level
   - Meet HSE requirements, during execution, and for the life of the Plant
   - Local Content: comply with regulations and objectives, contribute to local activities development
2. **Technical objectives**
   - Comply with all defined technical requirements, including audits and review, performance test
   - Implement applicable QA policy and QC system, achieve all tests, and 3rd party control
   - Avoid, or limit changes to the minimum necessary
   - Ensure all technical interfaces requirements are satisfied
3. **Project duration**
   - Comply with the Project schedule, avoid, or limit effect, of slippage and disruption.
   - Achieve timely provisional acceptance
4. **Project budget, and costs**
   - Complete the Project within the approved budget
   - Control all cost over-run, and changes from initial objectives
5. **Project stakeholders**
   - Identify and confirm roles and objectives of each/all participating entities
   - Promote effective and open communication.

Ensuring decision quality

- Identify key decisions in a timely manner and frame possible alternatives
- Studies performed to define the decision and support the recommendations
- Outcomes from studies are packaged together (DSP: Decision Support Packages or reports) to provide a high quality of information on which to base the decision
- Decision is reviewed and challenged in context of potential impacts to overall development
- Appropriate people are involved in decision process and decisions are endorsed by concerned management teams
- Audit trail is provided for future reference

Development concept selection and definition

- Concept screening should be as wide as possible as it will largely determine the project budget and economics
- Innovative ideas should be introduced at the conceptual stage provided they are mature enough
- The operability aspect should be one of the concept selection criteria (input from production personnel)
- The concept selection should result in a single development scheme
- Small or recurring projects could be sanctioned at the end of the pre-FEED studies (i.e. before basic engineering)
- But large, complex and expensive projects will be sanctioned after Basic engineering, receipt and evaluation of the Engineering, Procurement, Construction and Installation tenders



Scope

- Project Scope Management during Definition phase

Project Scope Management during Definition phase

- **Plan Scope Management**
- **Collect requirements**
- **Create WBS**
- **Define scope**
- **Validate scope**
- **Control scope changes**

Scope management plan

- Defines how the detailed scope statement will be defined
- Establishes phase to phase relationships
- Defines the process that enables the creation of the WBS
- Establishes how the WBS will be maintained and approved
- Defines acceptance criteria of completed deliverables
- Defines how requests for changes to the detailed scope will be processed

Project Scope Management during Definition phase

- Plan Scope Management
- Collect requirements
- Create WBS
- Define scope
- Validate scope
- Control scope changes

Owner's requirements

- **Appraisal and Development studies on one side and Definition studies on the other side (be them Basic Engineering or a Front End Engineering Design) are usually carried out by different teams within the Owner's organization**
- **Such move occurs between**
  - a conceptual engineering team
  - and a project organization
- **As a result, responsibility also shifts from one team to another and the latter team has to review and validate results obtained by the former one**
- **Owner's requirements are stated in Project technical reference documents such as**
  - Internal rules
  - General specifications

Host Country's requirements

- **Worldwide, Host Countries are increasing Local content obligations in Development projects**
- **These obligations are generally very ambitious:**
  - In terms of objectives:
    - National Preference
    - Spending as a percentage of investments,
    - Worked man-hours,
    - Transfers of technologies,
    - Maximization of local workforce,
  - And in terms of implementation speed
- **More and more the project faces legal obligations bearing strong constraints (with possible penalties)**

Local Communities' requirements

- **Local communities could request:**
  - Employment
  - Sanitary facilities
  - Roads
  - Electricity supply
  - etc.
- **Local communities' expectations are less formal than governmental expectations**
- **But local communities could slow down or stop the progress of works**
  - e.g. Nigeria, Yemen…

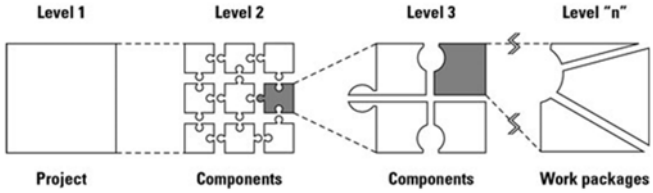
Local content management plan

- **Identify and gather all the data from**
  - the Production Share Agreement (or Contractor Participation Operating Agreement)
  - relevant laws and regulations
- **This data mostly consists in**
  - Mandatory documents or certificates, sourcing rules, recruitment and advertising rules, building capacity
- **But it could also feature, if applicable, the following**
  - Mandatory metrics Rules for establishing the vendor list
  - Rules for comparing offers with regard to the Local Content
  - Rules for assigning a contract or sub-contract to a local supplier
  - More generally, all obligations with regard to the Local Content and that have an impact on the Project strategy

Project Scope Management during Definition phase

- Plan Scope Management
- Collect requirements
- Create WBS
- Define scope
- Validate scope
- Control scope

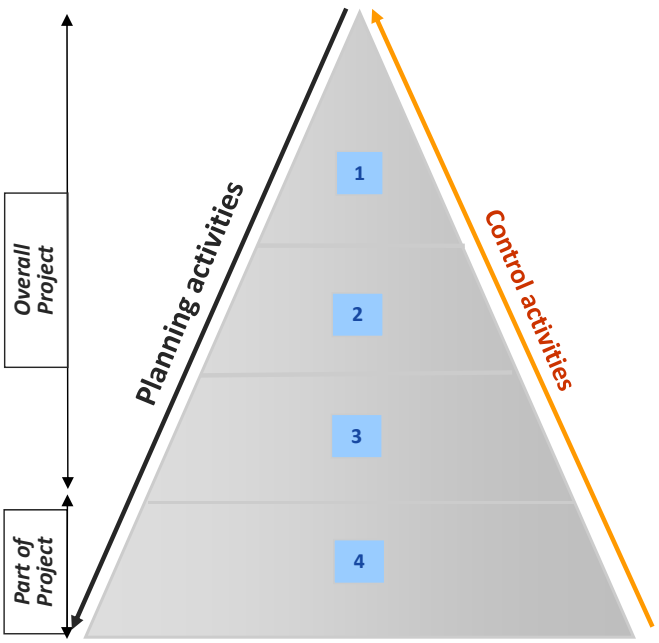
Work Breakdown Structure



- **Project complexity requires a hierarchical decomposition of the total scope of work into smaller, more manageable components to accomplish project objectives and deliverables**
  - The level of decomposition is guided by the degree of control needed to effectively manage the project
  - The WBS is defined by the Project Manager and the project team
  - A unique identifier is to be assigned to each work package for hierarchical summation of costs, schedules, and resources information
- **WBS definition may not be possible for deliverables to be produced far away in the future before the said deliverable is agreed**
- **Excessive decomposition can lead to non-productive management effort**

Work Breakdown Structure

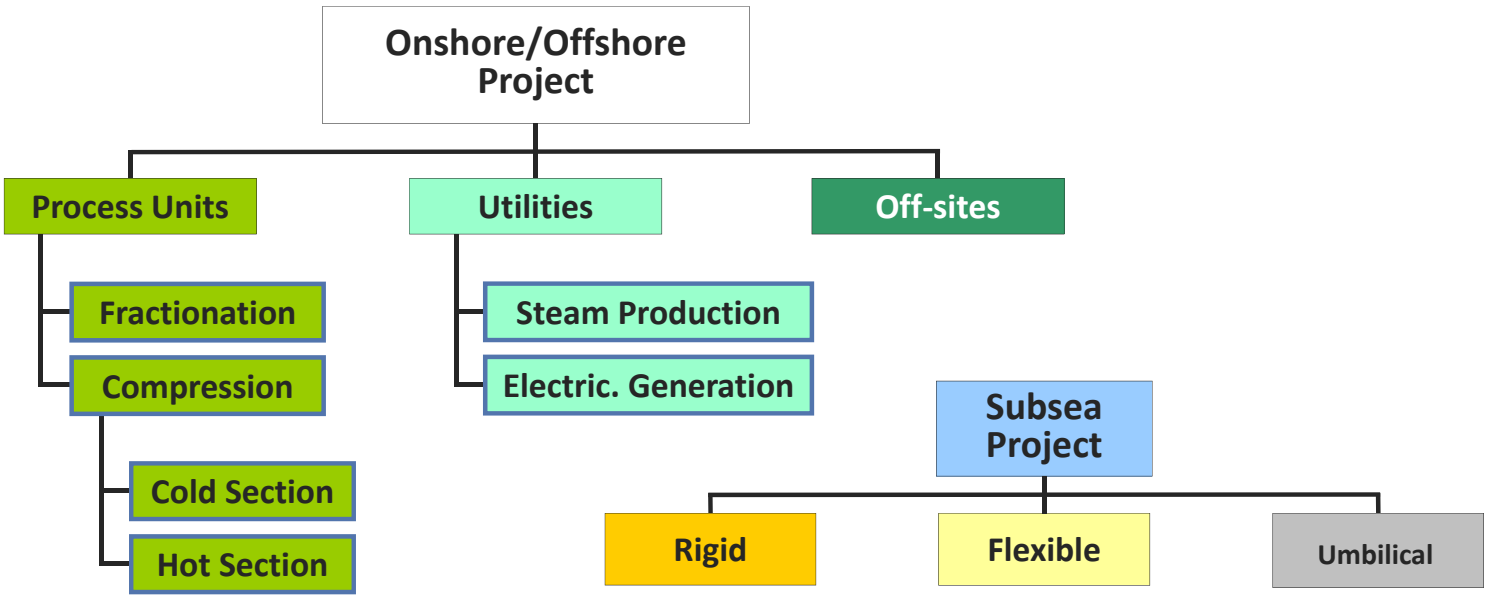
Components' hierarchy



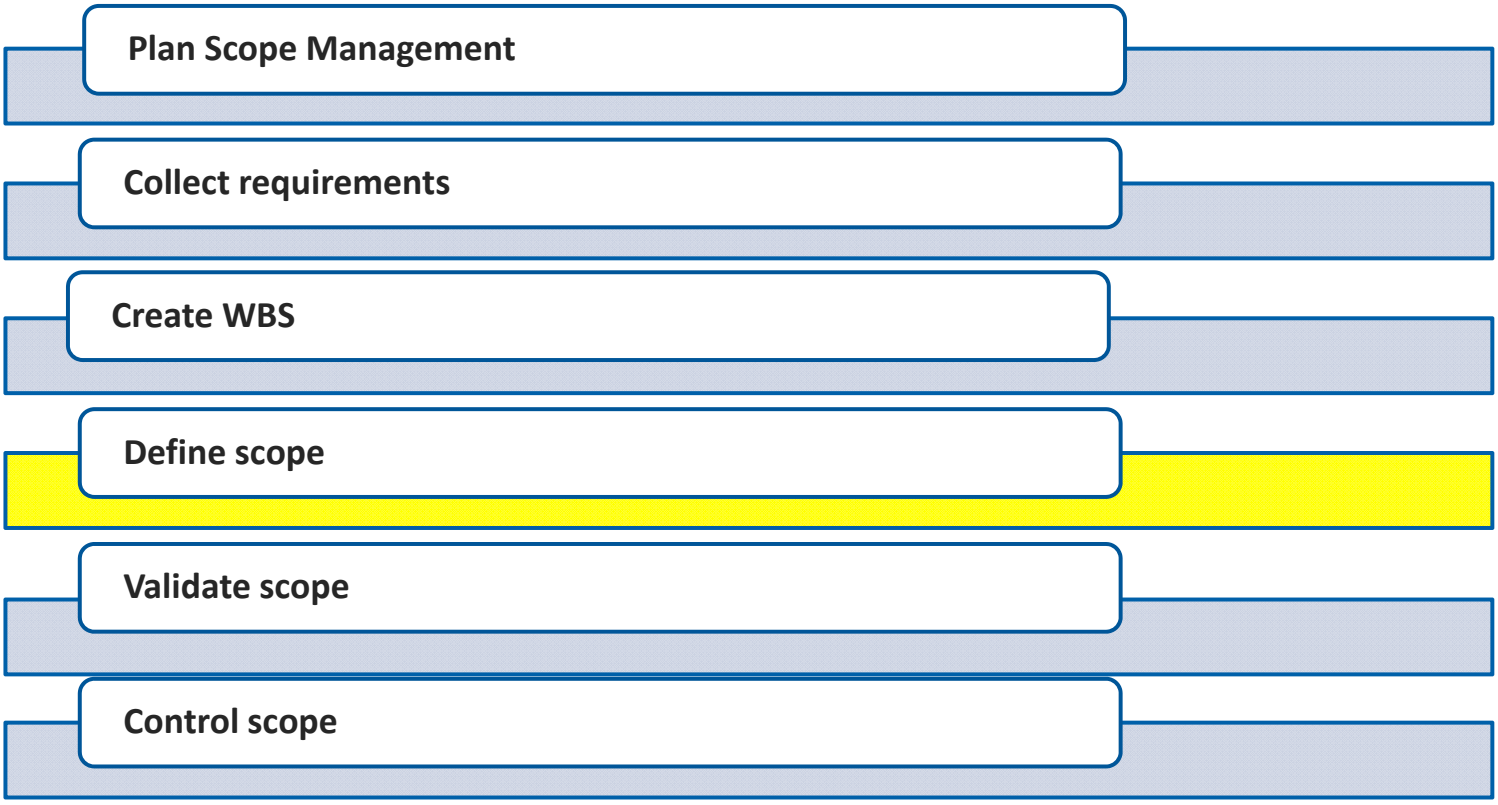
- The WBS is generally built with a top-down approach
- Information is rolled up with a bottom-top approach to produce an overall picture of the project

Work Breakdown Structure

- The WBS represents "what is to be done"
- And reflects the geographical and/or process split of work
  - Area, Unit, Platform, Function, etc.



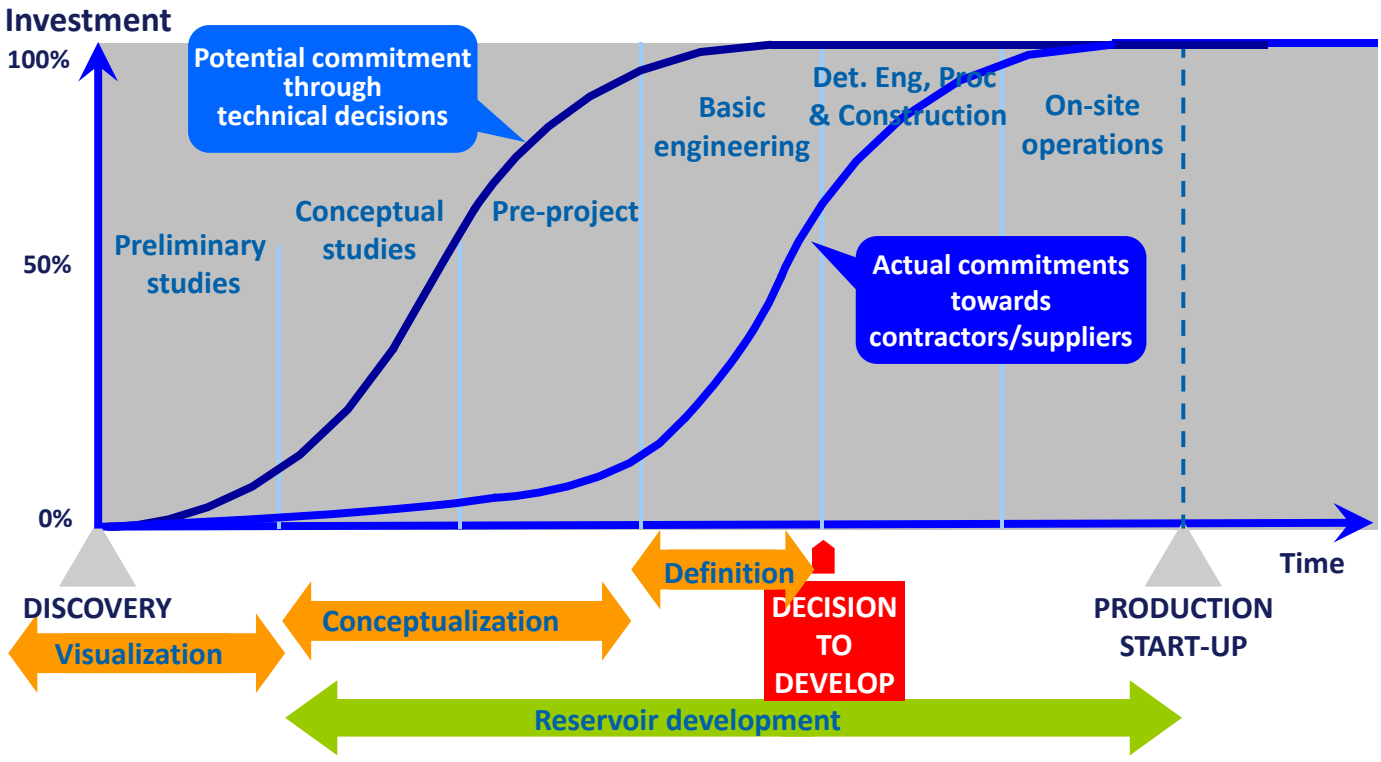
Project Scope Management
during Definition phase



Definition phase
Basic engineering or Front End Engineering Design

- **Scope:**
  - Develop the technical scheme approved at the end of concept selection to a level allowing the execution contracts to be placed and the Final Investment Decision to be made
  - Develop the project execution strategy
  - Identify and prepare bidding of Long Lead Items necessary to achieve the project schedule
  - Develop the contractual and technical documentation necessary for bidding the execution contracts (detailed engineering, equipment and construction contracts)
  - Compile the dossier required for Final Investment Decision (FID)
- **Objectives:**
  - Develop design to a sound, optimized, clear and suitable definition level in line with the contracting strategy
  - Define a robust Project Execution strategy, cost and schedule
  - Accurate contractual and technical documents to launch the execution contracts

Commitments during throughout the asset lifecycle



Pre-required reference documents

- **Project Development Plan**
  - Basis of Design
  - Reservoir Management Plan
  - Drilling
  - Architecture
  - Safety Concept
  - Budget & Schedule
- **Pre-Project or pre-FEED**
- **Statement of Requirements (SOR)**
- **Governing Agreement(s)**
- **Hazard Identification and Analysis (HAZID) and HAZOP No. 1**
- **Environment Base Line Study (EBS) and preliminary Environment Impact Assessment (EIA)**
- **Technical General specifications and Company Rules (Referential)**
- **Approvals of above documents (as required) by Operator, Partners and Authorities**

Main activities during the definition phase

1. **Development of the technical package with a level of details consistent with the execution strategy**
2. **Definition of the Project Execution strategy**
3. **Preparation of the contract support documentation**
4. **Preparation of the project sanction documentation**

1. Development of the technical package

Objectives

- **Comprehensive study by each engineering discipline of the technical solution established during pre-project**
- **Identify, assess and mitigate project risks**
- **Prepare technical specifications**
  - General, specific, licensing, BOD, certification specifications
- **Prepare documentation**
  - QA/QC, HSE, Safety Case
- **Issue Approved For Design documents**
  - drawings (layouts, P&IDs…) and equipment specifications
- **Identify packages to be covered by a license**
- **Identify requirements for Long Lead Items**
- **Prepare the technical dossiers for**
  - Long Lead Items
  - Licensors
  - Execution contracts to be awarded through a call for tenders

1. Development of the technical package

Technical package's content

- **In-depth safety and environment studies and deliverables to support the Safety Concept or Safety Case for the Project lifecycle and the Environmental Impact Assessment in adherence with Owner's policies and local requirements**
- **Specific studies/deliverables for Authority Engineering**
  - i.e. to meet Project Country regulatory requirements
- **Review and integration of licensors' Basic Engineering Packages**

1. Development of the technical package

Finalization of the technical dossier

- **The technical dossier shall be enhanced through systematic workshops attended by both parties**
  - The owner and its partners
  - Basic design contractor
- **Quality of the technical package is essential for Project successful execution since it provides the basis for**
  - Plant technical definition, scope and requirements
  - Development of Detailed Design by the selected detailed engineering contractor
  - Quotation by execution Contractor(s)
    - in particular in the case of Lump Sum contracts
  - Contractual documentation to be used during the execution phase
  - Project CAPEX estimate and Project Schedule supporting the FID
- **The finalised technical package shall be reviewed and approved by the Owner (and its Partners as required) and will form the basis for the execution phase**

1. Development of the technical package

Typical deliverables

- **For each function**
  - Engineering
    - Process
    - Thermal
    - Equipment and tanks
    - Corrosion/Piping
    - Civil/Buildings
    - Infrastructure
    - Electrical
    - Controls and Instrumentation
  - Procurement
  - Contracting
  - Construction
  - Safety and Environment
  - Commissioning
  - Quality
  - Project Controls

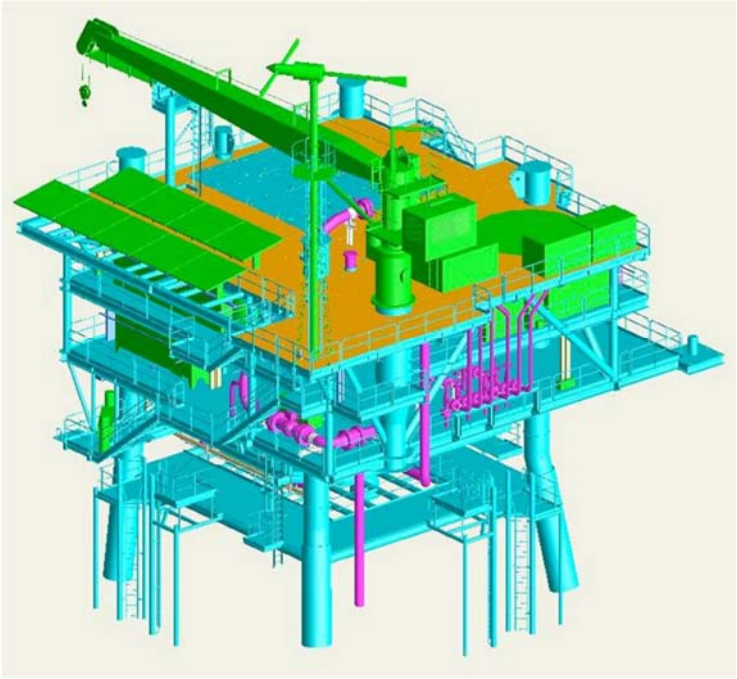
- **Typical content**
  - *Safety requirements*
  - *Design and construction standards and specifications*
  - *Construction particular requirements*
  - *P&I Diagrams*
  - *Interface requirements*
  - *Temporary construction facilities' requirements*
  - *Pre-commissioning and commissioning requirements*

1. Development of the technical package

3D models

- **3D Models are prepared during FEED for offshore facilities**
  - Platforms
  - FPSOs…

- **They are usually not prepared for onshore facilities, unless necessary to study in 3D the lay-out of particular areas or for modules in case of high density areas**



2 - Company and Contractor Project Execution Plans

- **A Project Execution Plan is established by Company as part of the FEED phase**
  - It is based on the contracting strategy adopted for the project
  - It is a part of the documentation required for Project sanction
  - It is also necessary to start discussions with the host country, especially in terms of local content objectives
- **Contractors will also establish a PEP as part of their response to the Invitation To Tender**
  - The PEP structure is the same as Company's PEP but with specific details of Contractor's offer
  - It will in particular give details about the Local Content proposed for the project
- **The Company's PEP will be updated to reflect all project execution details once all contracts will have been awarded**

2. Definition of the Project Execution strategy

Content of the Company's Project execution plan

- **General:**
  - Project Background and Description
  - Project Objectives
  - Project Management Organization
  - Project Committees and Reviews and Stakeholders Management Plan
  - Contracting Strategy
  - Local content management plan
  - Schedule
  - Budget
- **Procedures:**
  - Quality- Project procedures
  - Document Management
  - Training
- **Administrative:**
  - Delegation of Authorities and Responsibilities
  - Change Management
  - Identification and Management of Interfaces
  - Reporting and Action Tracking
  - Insurance
  - Permits and consents
- **Policy implementation:**
  - Risk Management
  - Health, Safety, Environment, Security and Sustainable Development

2. Definition of the Project Execution strategy

Content of the Company's Project execution plan

- Project description
- Project Organization
- Definition of project phases
- Contracting strategy: Outline content of each phase
- Reference documents and technical referential for the project
- Scope baseline and management principles
- Schedule baseline and management principles
- Cost baseline and management principles
- HSE management plan
- Quality management plan
- Risk management plan
- Human resources management plan
- Communication management plan
- Stakeholders management plan
- IP Protection
- Flawless Project Delivery
- Project control
- Interface management
- Split of scope of work
- Warranties and Guarrantess, performance Tests
- Licensors and rely upon information
- Pre-approved subcontractors

2. Definition of the Project Execution strategy

Main Contractor's project execution strategy highlights

- Contractor Execution Strategy addresses all key aspects of the project execution, as per and for its scope of the project
- Project description, objectives, global environment
- Contract and its requirements
- HSE & QA high level objectives, plan
- Coordination with Company
- Execution and Organization strategy (Partners/Nominated Contractors roles and responsibilities; organization charts, splits of work; communication and Project systems)
- Project Schedule key sequences, milestones, critical activities, constraints
- Use of Local resources
- Engineering specific and key aspects
- Procurement, Logistics/T&I strategy
- Fabrication/Construction contracts strategy
- Site Construction/Commissioning/Hand-Over strategy
- Interfaces and their management
- Project risks management

2. Definition of the Project Execution strategy

Project procedures' general topics

- **Project Management:**
  - General project management procedures
  - HSE
  - Quality
- **Project Controls:**
  - Personnel management and training
  - Delegation of authorities
  - Contracting procedures
  - Reporting
  - Document Management
- **Engineering**
  - Engineering organization and management
  - Engineering queries and deviation requests
- **Procurement**
  - Procurement
  - Material controls
  - Logistics procedures
- **Construction**
  - Construction procedures
  - Permit to Work procedures
- **Commissioning**
  - Commissioning procedures
  - Handover procedures
  - Performance tests procedure

2. Definition of the Project Execution strategy

The impact of Project location

Main drivers to be addressed:

- **Final Site location remoteness, specific new infrastructure such as: Artificial Islands, Permanent Port, Jetties, MOF, Local Permanent Bases, New Access Roads, Camps…**
- **In-country availability/qualification of Construction Contractors, Construction supervision workforce, Construction Materials may not be sufficient, and may require use of contractors/workforces from abroad, modularization and fabrication at yards, fabrication and integration of floating supports and integration at the site…**
- **Transportation logistics may be very complex due to quantities, worldwide procurement sources, and depending on distances from fabrication worksites which may require special transportation means**
- **Climate/oceano-meteo conditions, and in limited windows**

2. Definition of the Project Execution strategy

Constructability

- **The Project Constructability review will be an important contributor to the Project Execution Plan**
  - Construction and Commissioning Inputs into the Engineering
  - TCF areas
  - Traffic at site (equipment and personnel)
  - Accesses for equipment delivery, construction equipment and rigging/heavy lifts, lay-down areas
  - Accesses for modules delivery, lifting or rolling in-situ
  - Accesses and lay-down areas for maintenance
  - SIMOPs
  - Pre-fabrication plans
  - Module fabrication/delivery/integration plan for offshore facilities

2. Definition of the Project Execution strategy

Local content management plan

- **Defines and describes the means by which the Project team address the provision of Local Content within the project phase**
- **It will be based on legislative and contractual requirements together with Company Policy Guideline**
- **The Local Content Management Plan provides the tools, procedures and references to quantify, monitor, record and report the progress of the Project Local Content program, relative to established and agreed targets**
- **References:**
  - Rules, decrees and regulations of the host country where the Project is provided
  - Agreements between the Host Country and the Company (PSA, CPOA, etc.)

3. Preparation of the contract support documentation

FEED contractual and procurement activity input

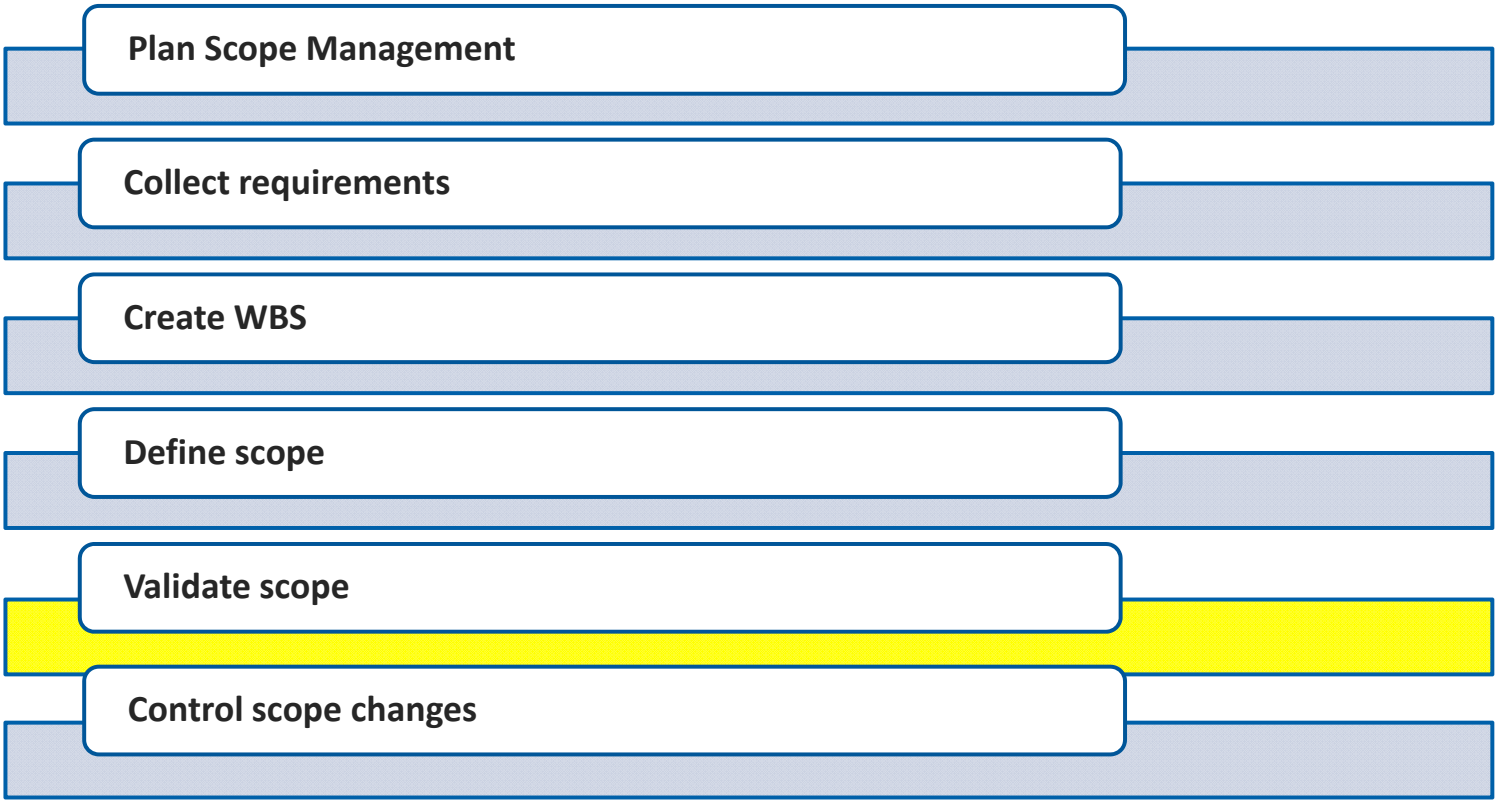
- **Prepare the contractual part of the call for tenders for LLI and EPC**
- **Issue the tenders evaluation procedures**
- **Launch the call for tenders for early works and LLI**
  - Evaluate results and prepare recommendations
- **Launch the call for tenders for EPC**

3. Preparation of the contract support documentation

FEED main deliverables Contracting & Procurement

- **Prequalification questionnaires**
- **List of pre-qualified companies**
- **Tendering Procedures**
- **CFT for EPCIC Contracts**
- **CFT for LLIs**
- **CFT for Early Contracts**
- **Tender Evaluation Reports**
- **Procurement requirements for the execution phase (for EPC CFT)**
  - Purchasing, Inspection, Expediting, Traffic
- **Approved Vendors list**

Project Scope Management during Definition phase



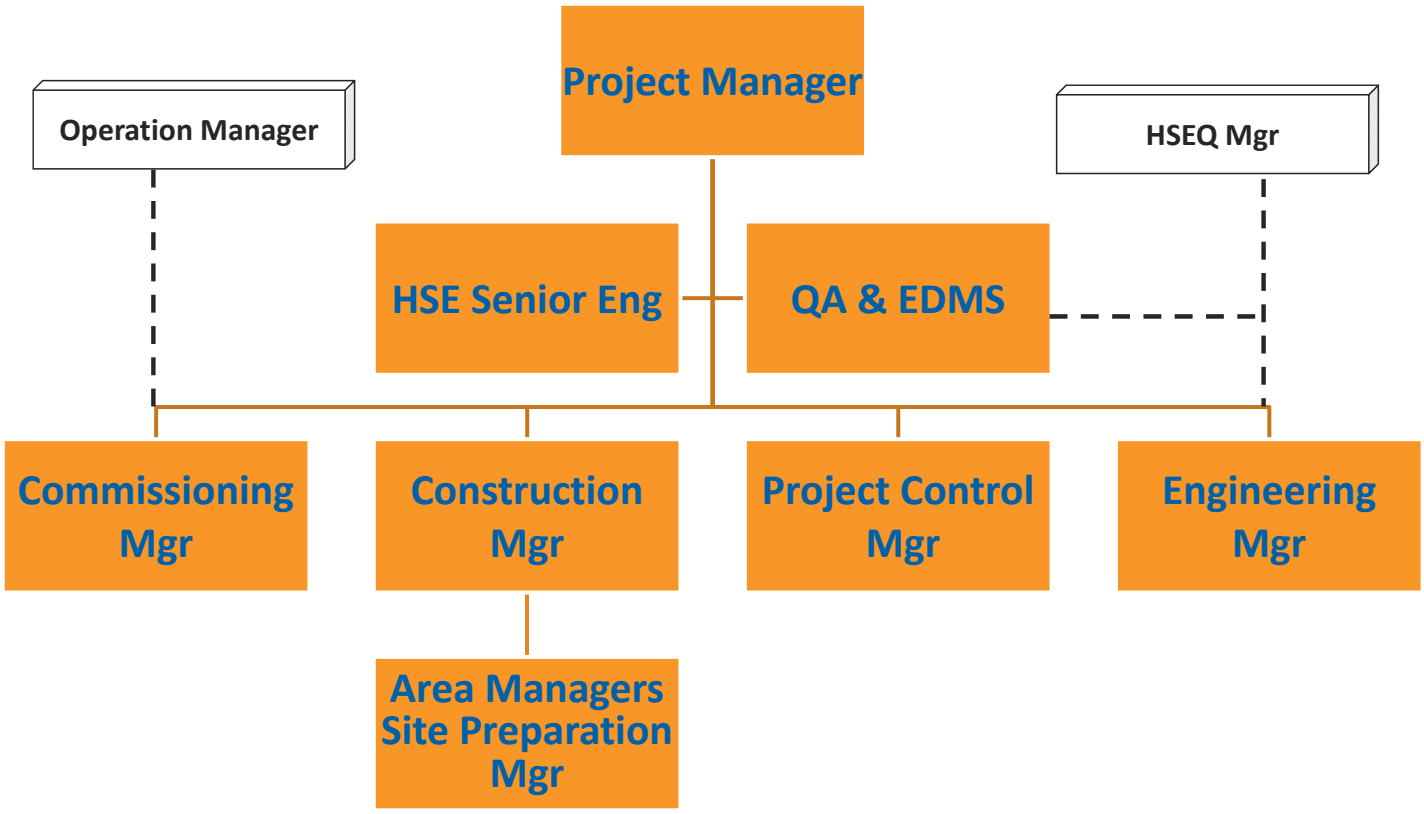
FEED project meetings & reviews

- **Project Meetings**
  - KOM global and by disciplines
  - Weekly management, disciplines; Monthly progress; ad-hoc meetings
- **Project Reviews**
  - Design Reviews
    - PFDs (Licensor's, Contractor's)
    - PIDs (Licensor's, Contractor's)
    - Plot Plans
  - Safety Reviews
    - HAZOP, HAZID
    - SIL or IPF (eventually)
  - Constructability Review
  - Value Engineering Review
- **Company Own Reviews (PTR…)**

Project sanction documentation

- **Project sanction is the Final Approval, from upper Management, Company Operator, Partners and Authorities, to proceed with project execution**
- **This decision is always formalized**
- **Economic studies with relevant risks evaluation and sensitivity analysis have to be provided as part of the recommendation to approve the Project**
- **The Final Investment Decision may take place *before* or *after* the FEED or Basic Engineering phase depending on the type of project**
  - Conventional projects (e.g. well known process units, in a well known environment): sanction can take place BEFORE Basic Engineering or FEED.
  - Complex projects (large & mega projects, remote, new environment/technology, deep water, HPHT…): sanction takes place AFTER FEED or Basic Engineering and often after evaluation of main contract tenders.

Typical project organization for FEED phase



FEED- contract types (pros & cons)

CONTRACT TYPE	BASIS	ADVANTAGES	DISADVANTAGES
At Cost (Re-imbursible)	All inclusive personnel manhours rates	Well suited when extent of studies, FEED scope cannot be fixed before start (generally the case)	Owner to closely follow Contractor mobilisation / demobilisation / manhours expenses and progress
	Office Cost		
	Lump Sum costs for studies not performed in FEED Contractor office (Consultants...)		
Cost + Fee	Personnel manhours rates	Same as above	Same as above
	Fee for CRP factor		
	Lump Sum costs for studies not performed in FEED Contractor office (Consultants...)		
Incentives	FEED Contractor payment is increased if given objectives are met or improved : maximum price, schedule adherence...or decreased if not met	Incentive to minimise FEED cost & schedule	May affect FEED quality
Cost + Fee ; ceiling price	same as cost + fee	Incentive to minimise FEED cost	May affect FEED quality
	but if manhours price estimate is exceeded, FEED contractor payment is reduced according to a given scheme		
Lump Sum	Fixed Lump Sum for services	Fixed price	Not well suited if FEED scope cannot be fixed before start
	Manhours rates for changes		
Design Competition	FEED Contractor also prepares an EPC bid . Payment is generally Lump Sum	Global Project schedule reduction. Generally cost is more than FEED cost and less than costs of FEED + paid bid	Owner has less control of FEED design which is generally less detailed than for a regular FEED
Guarantees	FEED schedule duration; schedule milestones		
	Design fit for purpose		
	Process design guarantees		

FEED typical durations & manhours

	FEED duration OOM	FEED manhours OOM
Medium size Project : -Addition of new Train -Limited Extension and Revamping	5 to 8 months	30,000 to 100,000
Grass-Roots Gas Plant medium size	8 to 12 months	100,000 to 200,000
Grass-Roots LNG Plant 2 Trains ; Large Gas Plant	12 to 15 months	150,000 to 250,000
Modularized LNG Plant , remote area ; Very Large Gas Plant	15 to 17 months	250,000 to 500,000

FEED Contractor Project Team may include more than 200 persons in the main centre + other teams in other centres

Project Scope Management during Definition phase

- Plan Scope Management
- Collect requirements
- Create WBS
- Define scope
- Validate scope
- Control scope changes
  - Managing changes to the scope baseline

Integrated Change Control principles

- Any modification to the agreed scope must be strictly controlled
- Each change (or configuration status) is accepted or rejected by an individual, generally the Project Manager
- A Change Control Board may be established to monitor the process
- Approved change requests may induce revised cost or schedule estimates
- A log of changes (approved and rejected) should be maintained
- Approved changes may require adjustment to the Project Management Plan or to project documents
- Configuration audits may be initiated to ensure that the project's configuration items are in conformance with the approved plan

SOR's modifications

- **SOR modifications are only to be made in a very controlled manner**
- **The design parameters in the SOR are categorized as follows:**
  - Fixed: No alternative to be further investigated. No change permitted without formal approval of the S.O.R. Signatories. The S.O.R. change procedure will apply in case of change.
  - S.C.N.* required: Base case + acceptable alternative options. The decision to freeze the design requires the formal approval of the S.O.R. Signatories. The S.O.R. change notice procedure will apply.
  - Non fixed: Base case + acceptable alternatives options to be further investigated during FEED or otherwise. The decision to freeze the design is the responsibility of the Project Manager.

SCN stands for: S.O.R. Change Notice

Summary



- **The project scope management covers processes to ensure that the project includes all the work required, and only the work required to achieve the project objectives**
- **Basic engineering studies scope (or FEED) further develops the concept selected at the end of the pre-FEED studies with the objective of:**
  - Providing sufficient detail to enable the execution contractor to prepare an offer
  - Minimizing risks of changes during project execution
  - Sanctioning the project on a sound basis
- **Basic engineering activities also cover the preparation of contractual documentation for the execution phase**
- **Long Lead Items have to be identified during this phase and the Invitation To Tender launched as required to protect the overall execution schedule**
- **A Project Execution Plan is prepared to detail execution plans**



Interfaces

Interface management

Foreword

- **Main objective**
  - Minimize the risks associated with interfaces
- **Main tools and means**
  - A structured system to manage the different types of interfaces
  - A dedicated organization to manage the interfaces between different contracts

- About interface management
- Identify interfaces
- Control progress of interface resolution
- Organization for interface management

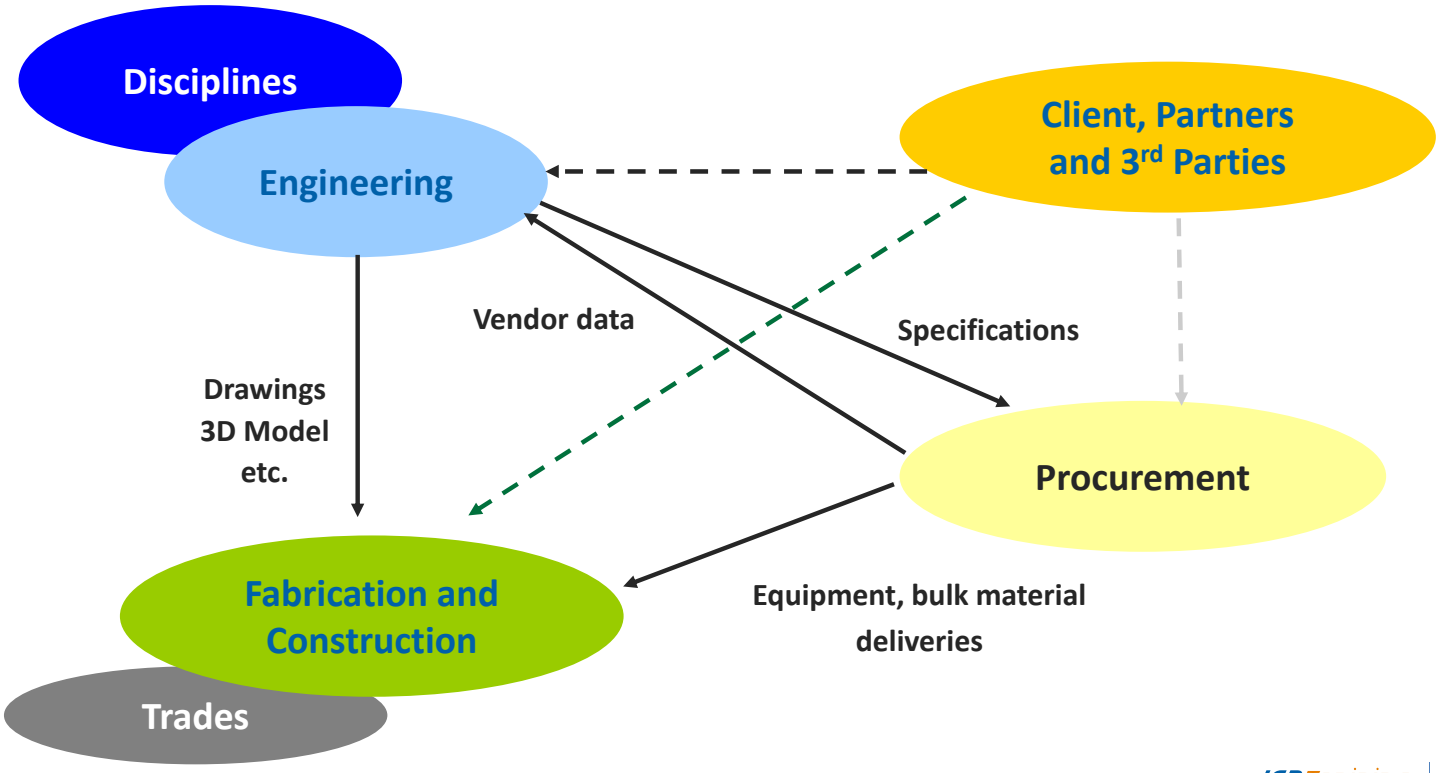
- **An interface is the point of exchange between**
  - Two different parts (e.g. pieces of equipment)
  - Two different parties (e.g. entities)
  - Two processes, more generally
- **It is important to implement a structured system allowing**
  - An exhaustive and correct identification of the interfaces (interface matrix)
  - Identification of the battery limits between different scopes of work
  - Follow-up of the resolution of the interface points
- **Interfaces represent an important source of risks for the project**
  - Optimum solution for the project may be different from the Owner's and Contractor's perspectives and between contractors
  - Conflict resolution principles to be agreed beforehand

- About interface management
- **Identify interfaces**
- Control progress of interface resolution
- Organization for interface management

- **Internal interfaces within a contract**
  - To be managed by the contractor
- **Interfaces between different contracts**
  - No direct contractual relationship between contractors
  - The owner is to be implicated in the management and resolution of the interfaces
- **Interfaces between third parties and the project**
  - To be managed by the owner
  - Impact on project scope to be managed through the change management system

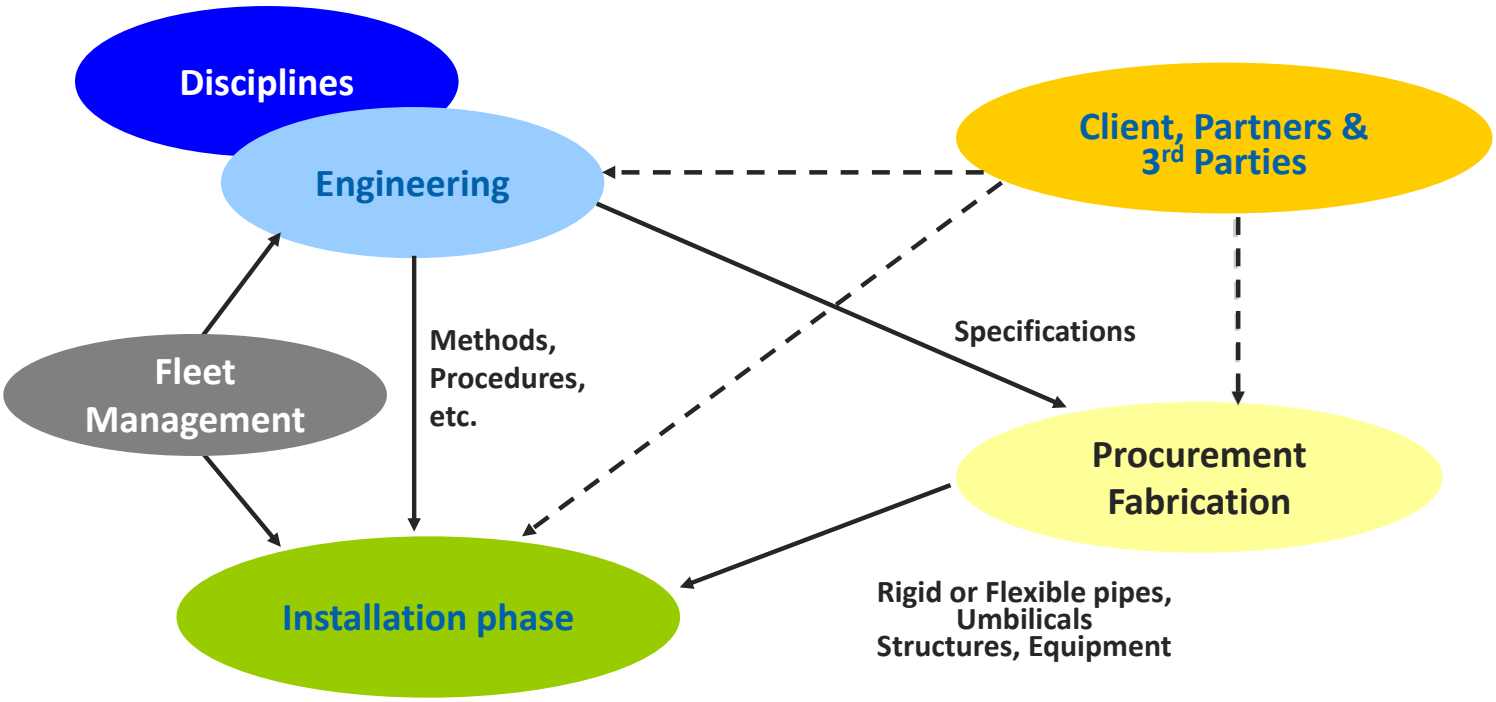
Main Interfaces between different entities

- Internal/external interfaces for Onshore/Offshore projects

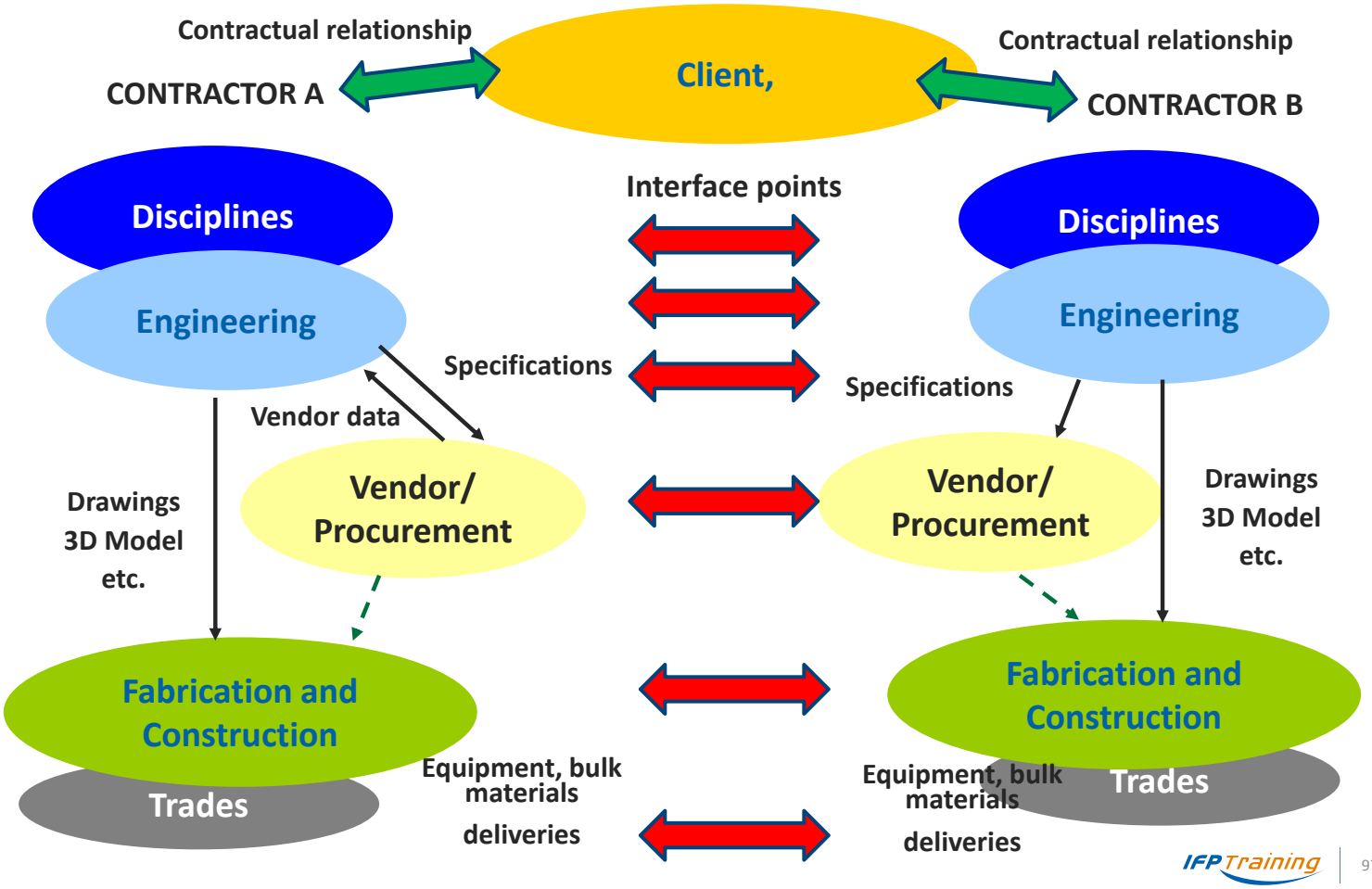


Main Interfaces between different entities

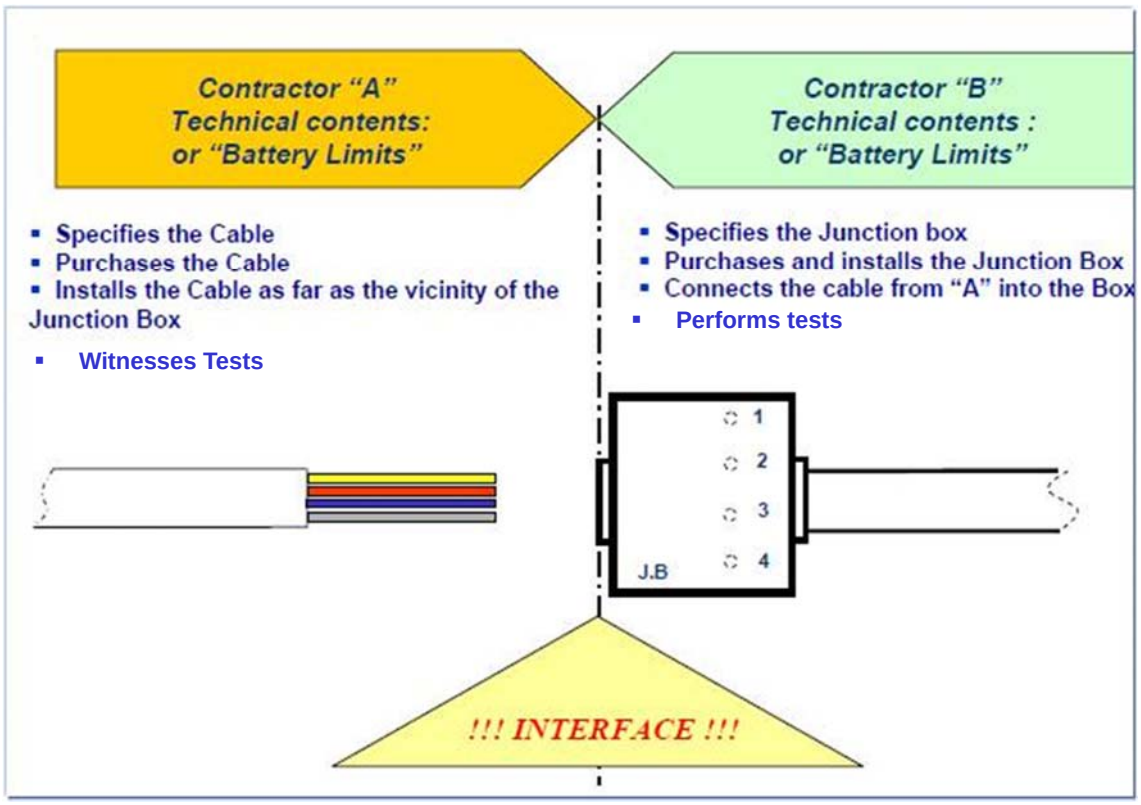
- Internal/external interfaces for a Subsea project



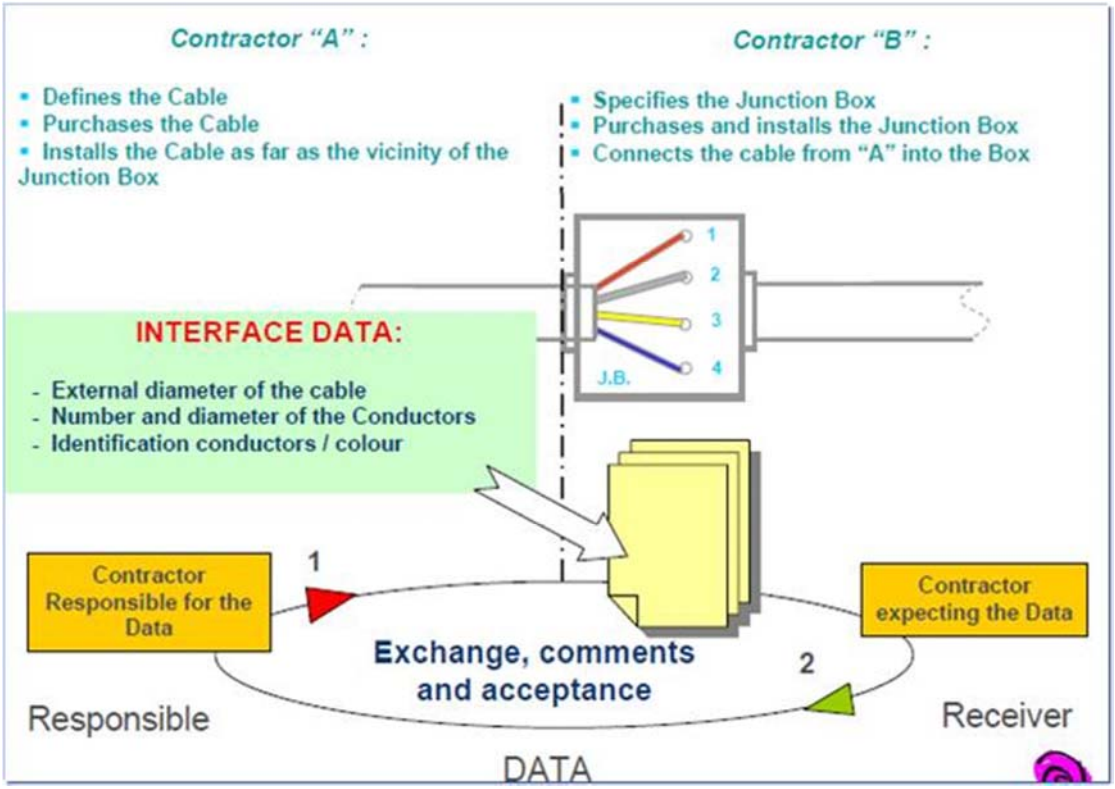
Main Interfaces between different contractors



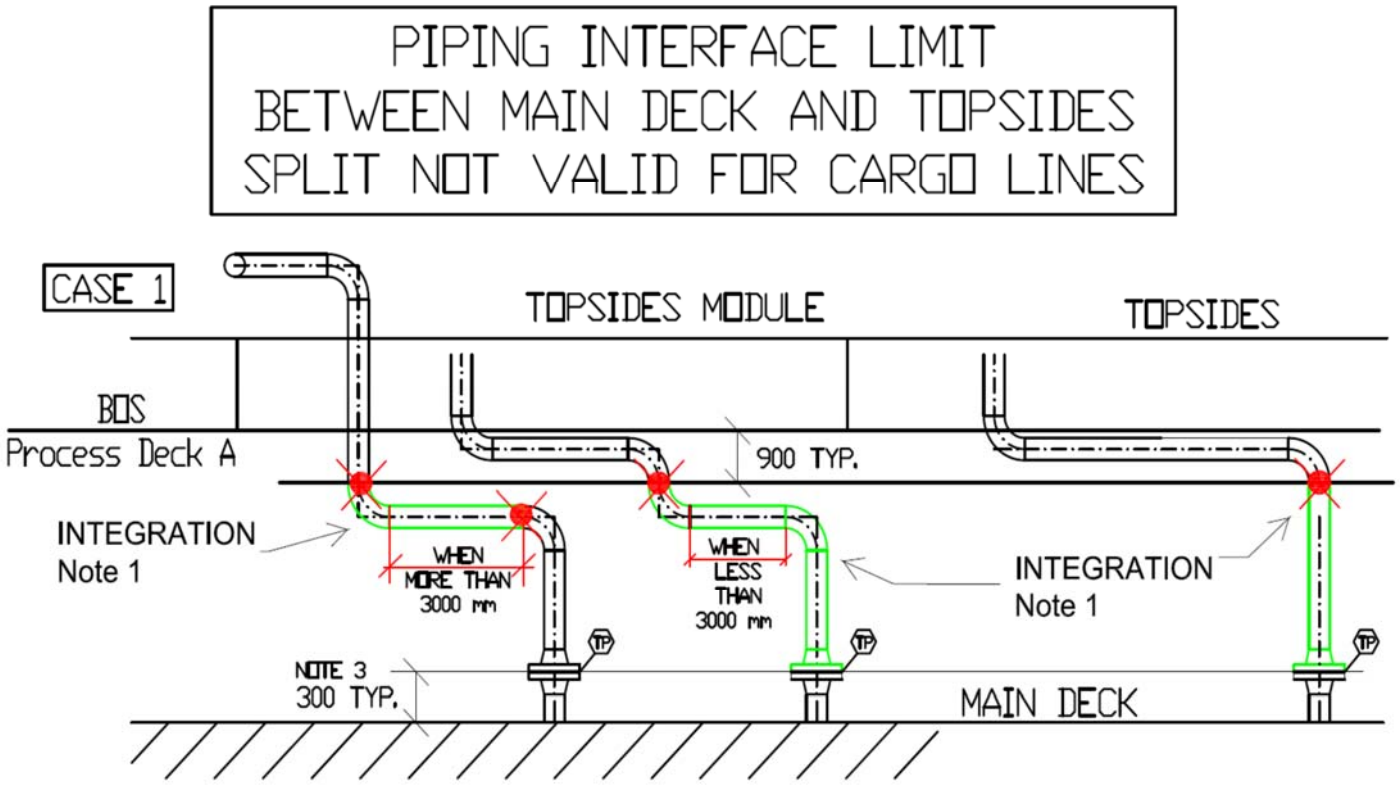
Interfaces between contracts



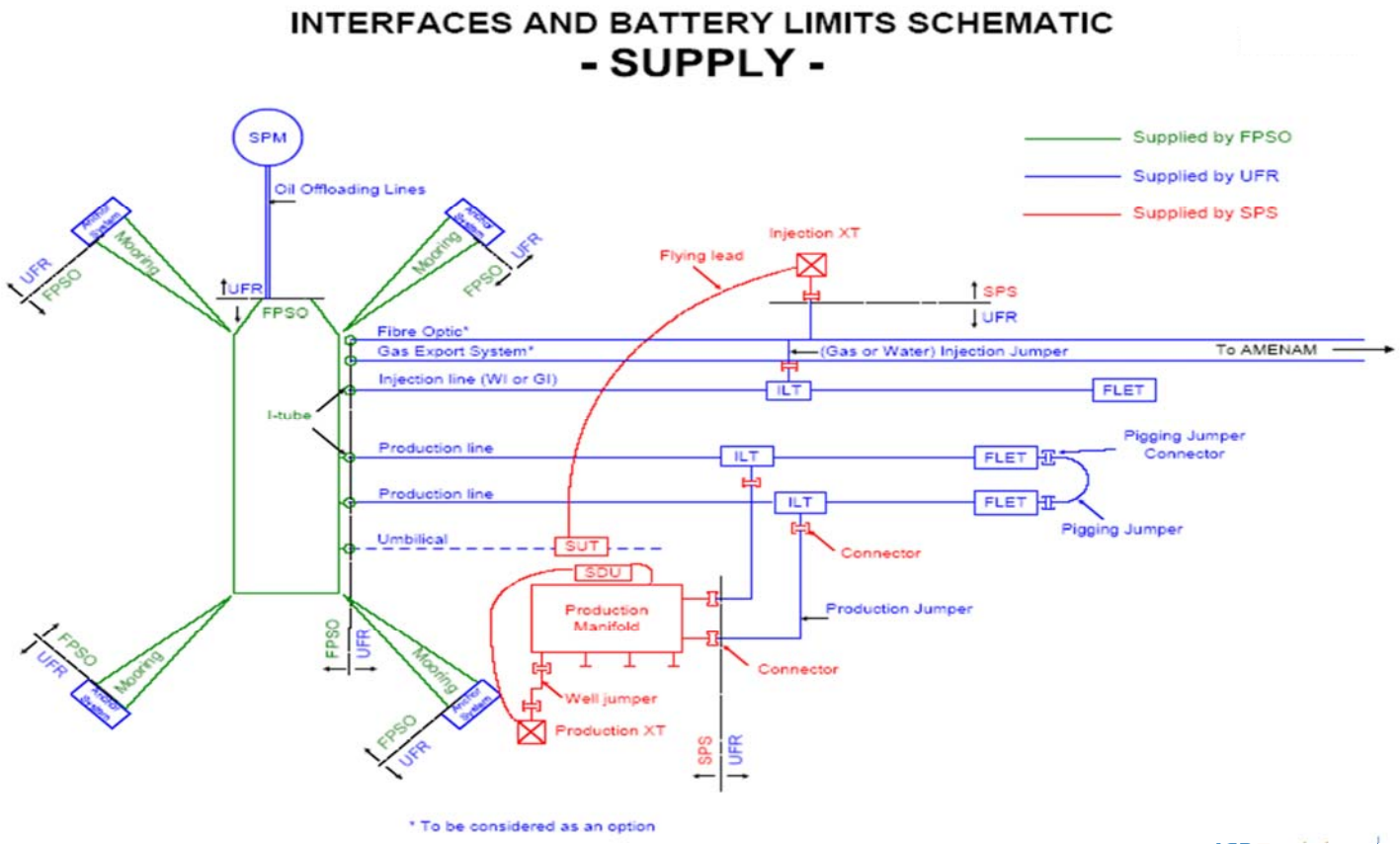
Interfaces between contracts



Interface between topsides and deck



Interfaces between contracts



Difficulties to identify all interfaces

- **Some interfaces can be identified right from the start of the project**
  - Contractual interfaces or interfaces between packages
  - Interfaces with the exterior of the project
- **But also some will appear during project execution**
  - Technical interfaces which could not be forecast due to lack of definition at project sanction
  - Due to project changes or external influences, etc.

Engineering interface management

- **Recording of activities and acceptance by each party to constitute the Interface register**
- **All interfaces need to be**
  - Individually identified and numbered as an IPS Interface Point, where S is a suffix that can be added to identify the relevant discipline
    - C for Civil; P for Piping; E for Electrical; I for Instrumentation; T for Telecom; B for Building, etc.
  - listed on an Interface List
  - described on Interface Drawings and represented with a dedicates symbol
- **The Interface List and Drawings shall show for each concerned party**
  - Their responsibility
  - Their scope of work
    - design data, supply, construction, testing
- **Actions related to each interface must be properly identified and documented**
  - Actions by each contractor to be formally agreed through approval of the interface register
  - Resolution of each interface to consider overall schedule to avoid creating delays to other contractors

Interface management

About interface management

Identify interfaces

Control progress of interface resolution

Organization for interface management

Interface management

Progress control

- **For projects with numerous interfaces, an interface progress control system should be set up, featuring**
  - Matrices with number of interfaces documents per contractor and per discipline in IFD and IFC status
  - An Engineering Interface management Schedule listing
    - interface documents and their planned and actual dates of resolution
    - IFD and IFC issues
    - progress curves for planned and actual IFD and IFC issues

- **Reporting to be featured in**
  - monthly progress reports
  - monthly Interface Review Meetings

Risks attached to interfaces

- **Interface not identified**
  - The problem will be discovered during construction or installation and might generate
    - Delays
    - Additional costs
- **Interface resolution out of sequence for one of the contractors**
  - The resolution might delay construction or lead to rework
- **Disagreement between contractors about the solution to be put in place**
  - Often related to budget matters
  - Arbitration by Company with the risk of having one of the contractors issuing a change order

- About interface management
- Identify interfaces
- Control progress of interface resolution
- **Organization for interface management**

Company organization

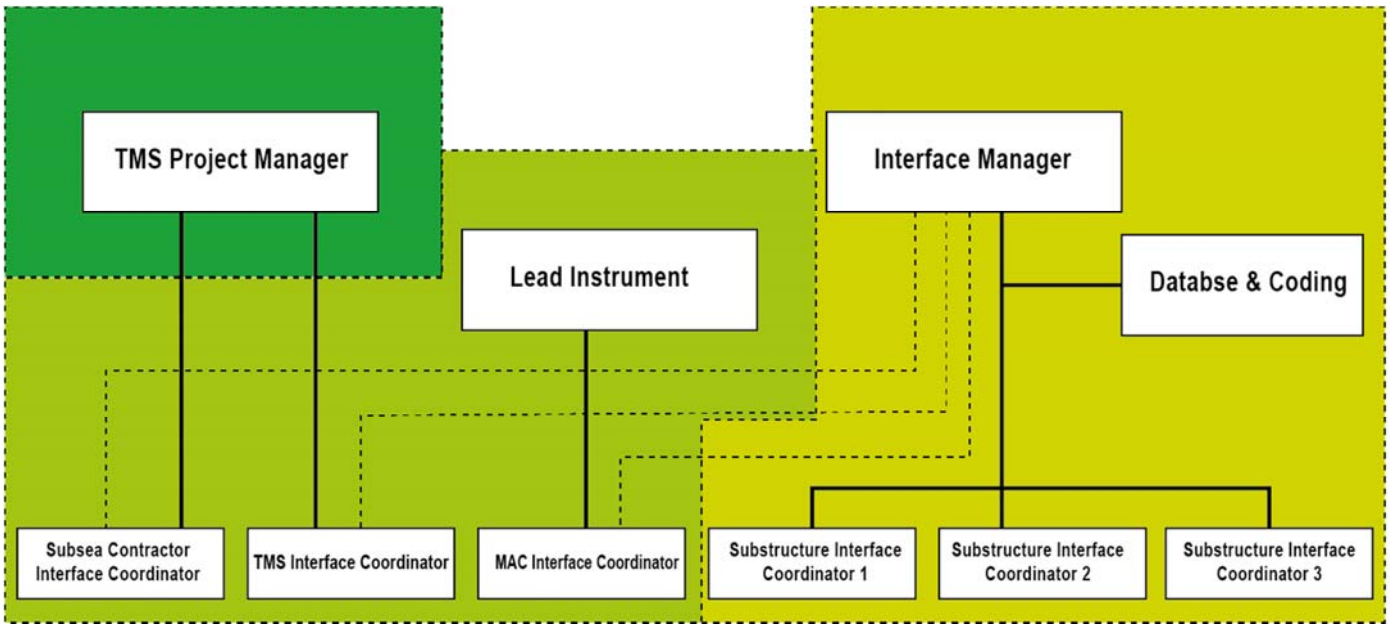
- For major projects, an Interface manager is nominated and reports to Project Manager or to work package leader
- Assisted by package Engineers
- Prepares Interface Management Procedures to define relevant
  - Scope (split between the two parties)
  - Responsibilities
  - Organization
  - Communication
  - Activity schedule
  - Overall management principles and work process, etc.
- Participates in Contractors' interface management meetings
- Coordinates interface resolution between different contracts
- Assists for resolution of major or conflictual interfaces and if necessary performs arbitration between conflicting positions

Engineering interface management

Contractor organization

- **For major projects, an Interface manager is usually nominated and reports to Engineering Manager**
- **For smaller projects, the Engineering Manager is usually in charge of engineering interfaces**
- **Assisted by Lead Discipline Engineers for the Leading Contractor/Partnership**
- **Prepares, with LDE's assistance, Interface Management Procedures to define relevant**
  - Scope (split between the two parties)
  - Responsibilities
  - Organization
  - Communication
  - Activity schedule
  - Overall management principles and work process, etc.
- **Manages**
  - The preparation by LDEs of interface drawings and documents for their disciplines and the preparation of General Interface Areas documents
  - Preparation and update of the Interface List, with the assistance of the LDEs
  - The formal agreement by both Parties on interfaces drawings/documents through exchange of communication/numbered correspondence (e-mails) and/or through interface review meetings
  - The issuing of the AFD/AFC interface drawings and documents; such interfaces might be shown on supporting engineering documents and/or on specific interface documents

Example of interface organization chart



Summary

- **Interfaces represent high risk for project objectives in terms of**
  - Budget increase
  - Schedule delays
- **They require special attention**
  - An interface register shall be kept to log all interfaces and the actions attached to each of them
  - A proper organization shall be set up to monitor the interfaces
  - Company and contractors shall work jointly on interface management
- **Conflicts between contractors shall be arbitrated by Company**



Foreword

Main objective

- Select the right contracting strategy between the Company and
  - Its contractors
  - Its vendors

Main tools and means

- Pros and cons of the various types of contracts in terms of
  - Contract perimeter
  - Remuneration method
- Main steps in the contracting process
- Understanding of how contractors build up a proposal

- **About Contracting activities**
- **Planning Contracting activities**
- **Selecting contract format**
- **Contracting process**
- **Bid preparation by tenderers**
- **Contractor selection**

Contracting strategy

- **Every Project needs a specific Contracting Strategy**
- **In other words, the following shall be defined**
  - Project breakdown into
    - Technical Contracts (not to be confused with Patrimonial Contracts)
    - Purchase orders
  - Scope for each of these
  - Their remuneration mode

Contracting strategy at owner (global project) level

- **What does it mean?**
  - How to divide the Project into sub projects.
  - Where to place interfaces and how to minimize/optimise them?
  - Which contract perimeter will be used:
    - E+P+C, EPC, EPCIC…
  - Which type of remuneration principle to be implemented:
    - Lump Sum, Price List, Reimbursable, Cost+Fee…
- **Several key aspects have to be taken into account**
  - Legal et local rules
  - Project size
  - Availability, qualification, experience and management of potential contractors
  - Availability of fabrication yards/T&I equipment
  - Company/Contractor risk sharing principles
- **Contract Strategy is a critical aspect of the project: cost and schedule can be badly affected by the contracting strategy**

Fundamental Definition

- **A Contract is a mutually binding agreement between two or more parties by which they commit themselves to fulfil defined obligations**

- **A contract is the tool by which, under certain conditions:**
  - The contractor agrees to carry out activities related to the performance of the project
  - The owner agrees to compensate the contractor for carrying out such activities
  - Owner and Contractor define how to share the project risks between them

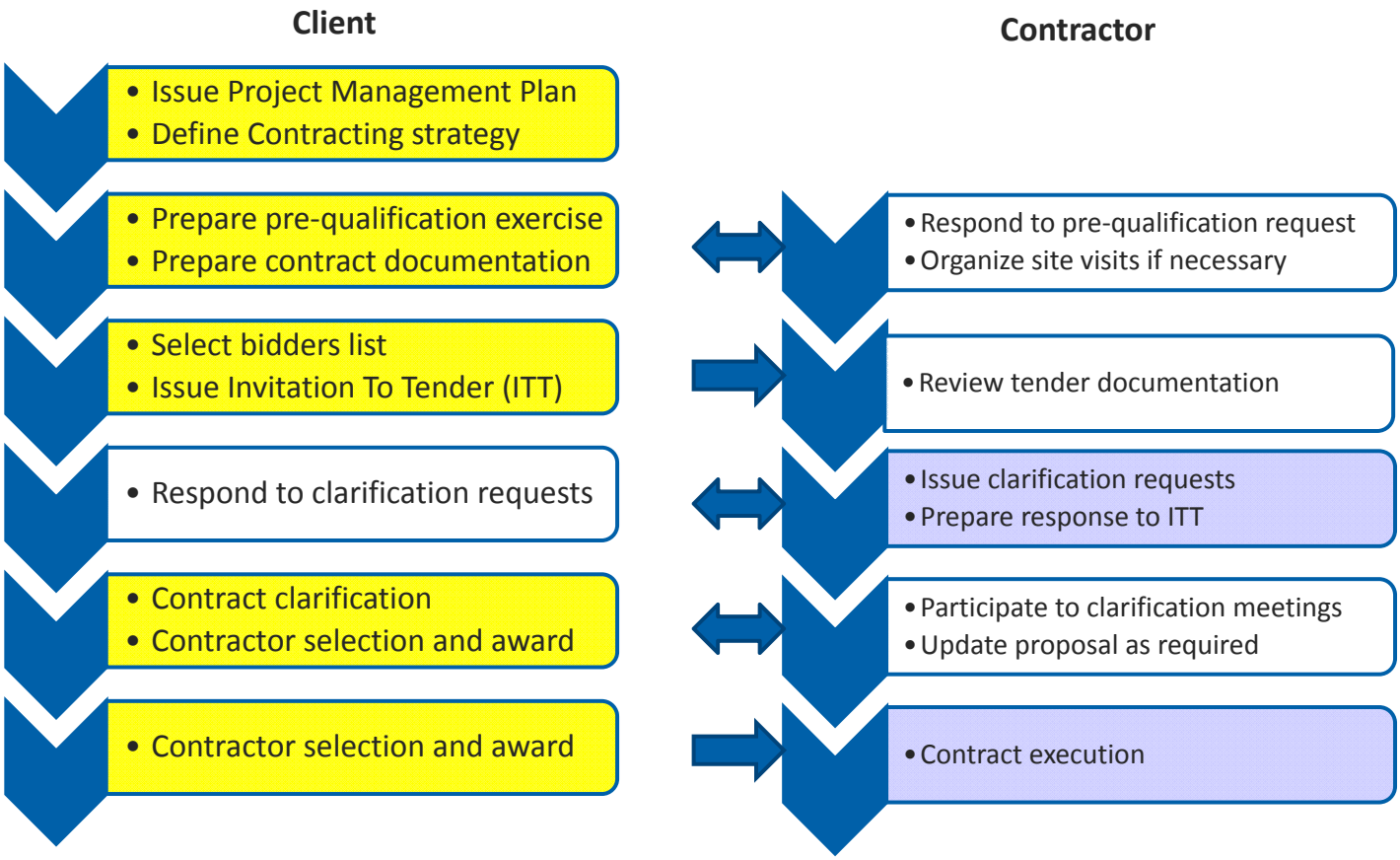
Main differences between Contracts and Purchase Orders

CONTRACT	PURCHASE ORDER
Includes in general several disciplines: engineering, fabrication…	For an equipment or materials issued from standard fabrication
May be performed at several sites including the final project site	Fabrication will take place at supplier's premises
Contract documents are based on Company's detailed requirements	The purchase order is based on supplier's definition, accepted by the buyer
The result of the work will be checked at the Owner's site	The result of the supply will be agreed upon delivery with a warranty period
Overall responsibility of the Work, liability could be very large. i.e 100%	Responsibility limited to the supply and compliance with the specification.
Payment can be by unit rates, time rates, progress, milestones	Using milestone payment is the normal procedure
May endorse several orders from the owner	May be used for packages (several equipment for a specific process)

Technical contracts

- About Contracting activities
- **Planning Contracting activities**
- Selecting contract format
- Contracting process
- Bid preparation by tenderers
- Contractor selection

Flow diagram of contracting activities



Planning Contracting activities

Input

- Project Management Plan
- Scope of work/WBS
- Project schedule
- Risk register
- Resource requirements
- Local content requirements

Tools and techniques

Output

Planning Contracting activities

Input

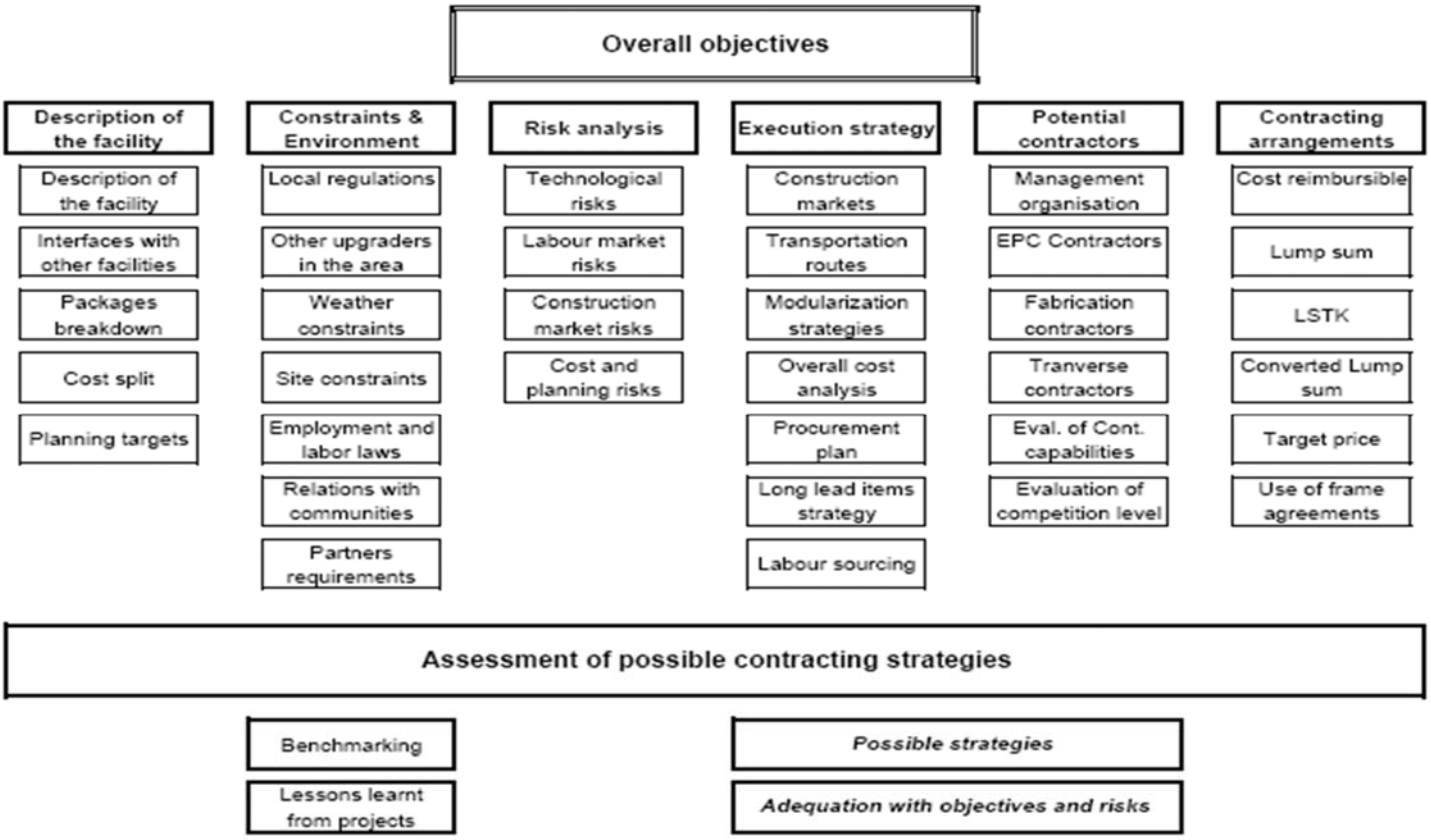
Tools and techniques

- Project team analysis
- Expert judgment
- Lessons learnt from past projects
- Market intelligence
- Stakeholders' input

Output

Planning Contracting activities

An exemple



Planning Contracting activities

Input

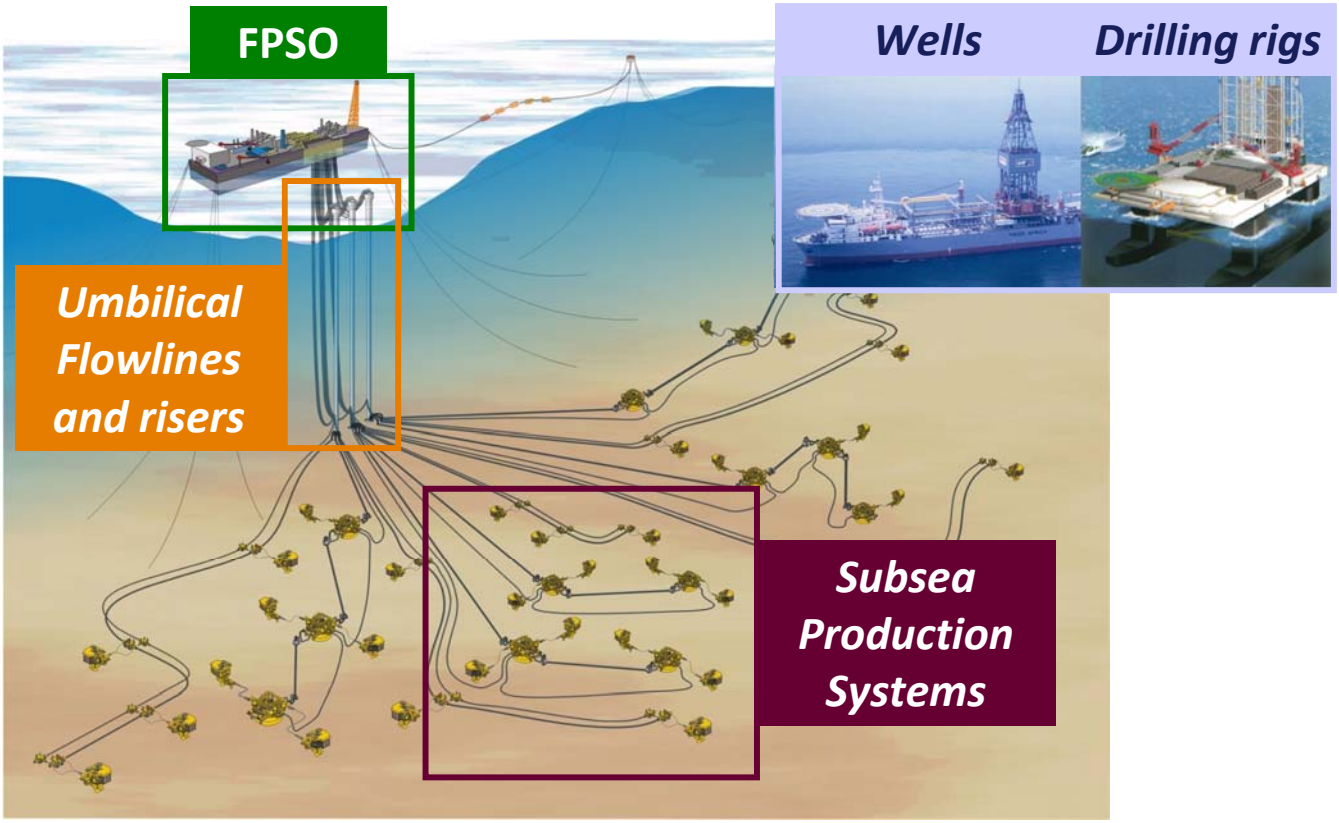
Tools and techniques

Output

- **Contracting plan**
- **Contracts scopes of work**
- **Interfaces definition (contractual and technical)**
- **Project organization**
- **Contract documentation**

Example of Contracting Strategy

Case of a Deep Offshore Project



Example of Contracting Strategy

Case of a Deep Offshore Project

	Subsea Production Systems				Umbilicals Flow lines and Risers					FPSO			
	Wellheads and Xmas trees	Subsea control system	Manifolds	Jumpers	Umbilicals	Flowlines	Risers	Offloading terminal	Gas export pipeline	Mooring	Hull	Topsides	Control system
Basic Engineering	Company												
Tender cycle													
Detailed Engineering	SPS EPC Contractor				UFR EPCI Contractor					FPSO EPC Contractor			
Procurement													
Fabrication & onsh. commiss.													
Transportation													
Installation	Drilling Contractor												
Hook-up/Tie-in	N/A												
Offshore commissioning	Cy with Cr assistance	Company with UFR Contractor assistance								FPSO Contractor with Company assistance			
Start-up	Company with Contractors assitance												
Operations	Company												
Well equipment	Procurement by Company												
Drilling Rig	Drilling Contractor												

Example of Contracting Strategy

Case of an Onshore Project



Technical contracts

- About Contracting activities
- Planning Contracting activities
- Selecting contract format
  - Scope perimeter
  - Remuneration structure
- Contracting process
- Bid preparation by tenderers
- Contractor selection

Selecting the right contracts perimeters

- **Multiple separate contracts**
  - Contracting Strategy leading to separate contracts
- **Combined contracts:**
  - EP: for Engineering, Procurement and usually construction & commissioning assistance or supervision
  - EPC: for Engineering, Procurement, Construction until Ready For Commissioning (RFC)
  - EPCC: for Engineering, Procurement, Construction, Commissioning until Ready For Start-Up (RFSU)
  - EPCIC: for Engineering, Procurement, Construction, Installation, until Ready For Start-Up (RFSU)
  - EPCm: for Engineering, Procurement, Construction management.
  - T&I: Transport and Installation
  - Turn Key contracts
  - Project Management Contract (PMC)
- **Particular contracts: Design Competition**

Different contract scopes

Separate contracts	EPCm	EPC	EPCC	Turn Key
	Pre-FEED, FEED, EPCI	Pre-FEED, FEED, EPCI	Pre-FEED,FEED,	
PRE-FEED	PRE-FEED	PRE-FEED	PRE-FEED	PRE-FEED
BASIC or FEED PROCUREMENT LONG LEAD ITEMS	BASIC or FEED DESIGN PROCUREMENT SERVICES FOR LONG LEAD ITEMS	BASIC or FEED DESIGN PROCUREMENT SERVICES FOR LONG LEAD ITEMS	BASIC or FEED DESIGN PROCUREMENT SERVICES FOR LONG LEAD ITEMS	BASIC or FEED DESIGN DETAILED ENGINEERING
DETAILED ENGINEERING PROCUREMENT	DETAILED ENGINEERING PROCUREMENT	DETAILED ENGINEERING PROCUREMENT	DETAILED ENGINEERING PROCUREMENT ASSIGNMENT LONG LEAD ITEMS	PROCUREMENT
SUPPLY OTHER EQUIPMENT BULK MATERIALS	SUPPLY OTHER EQUIPMENT CONSTRUCTION MGT	SUPPLY OTHER EQUIPMENT BULK MATERIALS	SUPPLY ASSIGNED L.L. ITEMS OTHER EQUIPMENT	LONG LEAD ITEMS OTHER EQUIPMENT
CONSTRUCTION	CONSTRUCTION	CONSTRUCTION INSTALLATION	BULK MATERIALS	BULK MATERIALS
			CONSTRUCTION	CONSTRUCTION
COMMISSIONING	COMMISSIONING	COMMISSIONING	COMMISSIONING	COMMISSIONING AND START UP

Particular considerations related to Transport & Installation contracts

- Definition of responsibilities and battery limits
- Provision of equipment and services by third parties (incl. CPY)
- Liquidated damages (late mobilization, removal of key personnel, late completion)
- Booking fee may be required to secure equipment availability and installation schedule
- Installation windows notification mechanism
- Weather standby
- Criteria for standby due to operational failures
- Standby rates
- Conformance definition

Interim certificates to be issued

- Ready for Load Out
- Ready for Transportation
- Ready for Installation
- Marine Spread Release
- Ready for Commissioning
- Ready for Operational Test
- Ready for Hand Over

General evolution of contracting strategies

Example of a Pipeline Project

1970s Several Separate Contracts	1980s Several Grouped Contracts	1990s Grouped Contracts	2000s Global Contract EPCC	2010s Several EPC Contracts
Studies	Studies	Studies	Studies Pipes Coating Storage Laying Tie-ins Hydro tests Burying Landing As-Built surveys Commissioning	Studies
Pipes	Pipes	Pipes		Pipes Coating Storage
Coating Storage	Coating Storage	Coating Storage Laying Tie-ins Hydro tests Burying Landing As-Built surveys Commissioning		Laying
Laying Tie-ins Hydro tests Burying Landing As-Built surveys	Laying Tie-ins Hydro tests Burying Landing As-Built surveys			Tie-ins Hydro tests Burying Landing As-Built surveys
Commissioning	Commissioning			Commissioning



1 - Separate contracts

- **Advantages**
  - Owner has full control of all phases of activities
- **Disadvantages**
  - Many interfaces between contracts, more control required
  - Large management team to award and to supervise all contracts
  - Longer delay for all contracts to be approved by Partners and Authorities

1- Separate contracts

Exemple – NKOSSA FPS (floating production barge)



Owner:	**ELF Congo**
Location:	**Guinea Gulf - Offshore Congo**
Completion:	**1996**
Anchored production Barge (NKP) 240m x 46m	
Total Weight:	**100 000 tons**
Concrete Hull:	**70 000 tons**
Topsides:	**30 000 tons**
Oil production:	**120 000 bpd**
Gas dehydr./extract.:	**13 million Scm/day**
Condensate:	**1 300 T/day**

1- Separate contracts

Example – NKOSSA contracts

- **EPCm Contractor**
  - Basic and detailed engineering of topsides Procurement services
  - Assistance during construction, installation and commissioning
  - Final documentation (operating manual, maintenance manual)
  - Barge engineering and design
- **Barge Fabrication**
- **Module Fabrication at 3 yards (France, Italy, Netherlands)**
  - 6 gas compression modules weighing up to 5000 tons
- **Transport & Installation to Marseille**
- **Integration, Hook-up and Commissioning at yard**

2 – EPCm contract

EPCm Contract *WHY and WHEN*

- **Scope: limited to E, P* and Construction *management* only**
- **Advantages**
  - Flexibility for project changes: better suited for Projects with novel aspects or particular execution uncertainties
  - Allows closer visibility and Project governance by Owner
  - Shortens the global Project schedule by shortening the tendering period
- **Disadvantages**
  - Larger Owner's risk on Project price and schedule

**** The scope may in certain cases be also limited to Procurement services only***

3 – EPC contracts

EPC contracts WHY and WHEN

- **Advantages**
  - Limits the number of contracts and approvals
  - Limits the Owner's risk
  - Reduces interfaces between engineering/procurement/fabrication/construction phases
  - Reduces the Owner supervision team
- **Disadvantages**
  - Limited competition among contractors
  - A large part of the Project governance is delegated to the Contractor
  - Limits the control on Detailed Engineering, Procurement and Construction
  - Potential high claims by Contractor

3 – EPC contracts

Remaining risks for the Owner:

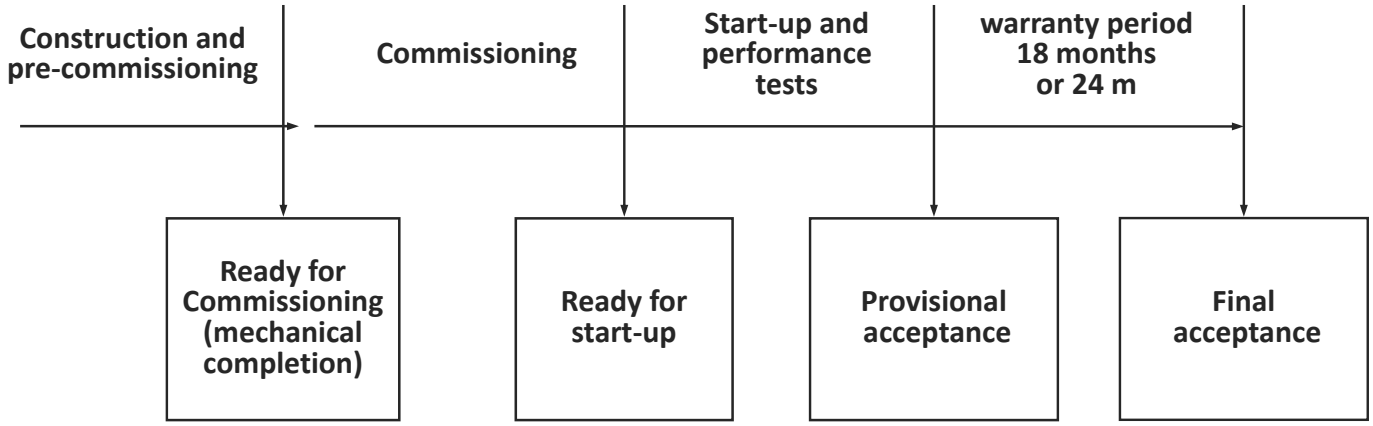
- **Preparation of plant definition**
- **Definition of plant performance criteria to be met by the Contractor**
- **Interfaces between the FEED, Early Contracts and LLIs (if order placed by Owner) and the plant as designed by Contractor**
- **Generally, an endorsement of the FEED results by the Contractor is put in place to reduce above risks**
- **Limited flexibility with respect to late design modifications regardless of the justification of the design modification**
- **A more limited competition with uncertain prices:**
  - The number of contractors able to work in certain countries and/or mastering particular technologies (e.g LNG) within the frame of a major project is sometimes restricted to three or less
  - The Owner needs to investigate as early as possible the willingness of potential contractors to compete (pre-qualification)

4 – EPCC contract

EPCC (i.e. until RFSU) Contract WHY and WHEN

- **Commissioning is included in the scope of the Contractor**
  - This is possible when the Contractor has enough knowledge of the technology used and the operating principles
- **For the same reasons as for the EPC, reasons for choosing this type of contract are to reduce the Operator's risk**
- **EPCC is only possible if the performance of the plant can be measured without uncertainties; should the performance be dependant of external factors, then such transfer of responsibility is a challenge**

Guarantees in an EPCC contract



Performance guarantees (capacity, products, utilities, global operability, possibly some packages and/or equipment…)

Schedule guarantee (possibly several deadlines and /or milestones)

Cost (global Total Installation Cost)

Whatever the contract type, EPC Contractors' liabilities with respect to warrantees (cost, schedule, performance, mechanical guarantee…) will be limited, generally in proportion to the Contract PRICE for Contractor

Liabilities are hence higher for an EPC LS than for an EPCm contracts. Company will always bear risks beyond those born by Contractor.

Large EPCC contracts

Examples

Usually used for large and mega Projects (including start-up assistance):

- **Onshore: most LNG Projects, Gas Plants…**
- **Offshore: FPSOs and Deck Platform projects, by an EPC Contractor, in Consortium with a Yard**

Turn Key contracts *WHY and WHEN*

- **Advantages**
  - Limits the number of contracts and approvals
  - No interfaces to be managed by the Owner
  - Very limited Owner supervision team
- **Disadvantages**
  - Limited competition among contractors
  - Complete Project governance delegated to the Contractor
  - No control over Detailed Engineering, Procurement and Construction
  - Potential high claims by Contractor

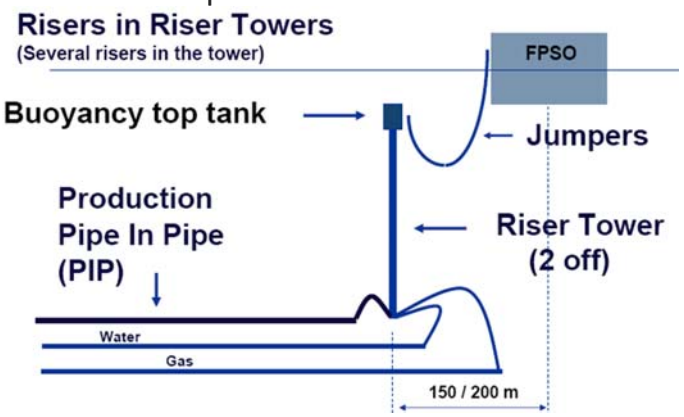
- **In PMC contracts the Contractor**
  - Performs the FEED studies
  - Assists the Owner to organize and split the Project into large Work Packages
  - Prepares CFT for Work Packages on EPC, or EP and C basis…
  - Manages and Controls the execution by Work Packages carried out by subcontractors
- **The Owner keeps direct contracts with all subcontractors**
- **Examples:**
  - Offshore/Onshore Large Field Developments
    - Kashagan Field Development
    - NW Libya Field Development
    - North West Shelf Field Development
  - Onshore Large Field Development
    - Hawyiah Gas Field Development

7 – New approach: design competition

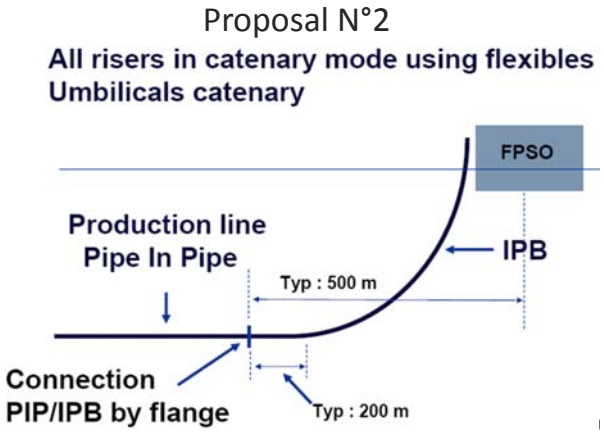
- **Instead of bidding a fixed design based on the results of a Basic Engineering, the contractor is requested to bid their preferred design fulfilling functional requirements defined by the project**
  - Examples: Girassol, Dália and Pazflor UFR, CLOV FPSO, SPS, Gas plants, LNG plants
- **Advantages**
  - Contractor can provide a design they have already studied: cost reduction
  - Contractor can provide their own in-house design
  - Open to innovative designs
- **Difficulties**
  - Technical follow-up of the design competition can be more difficult: more resources needed
  - Consistency with Company rules may be problematic
  - Comparison of the resulting solutions may be more difficult

Example: design competition for a riser system

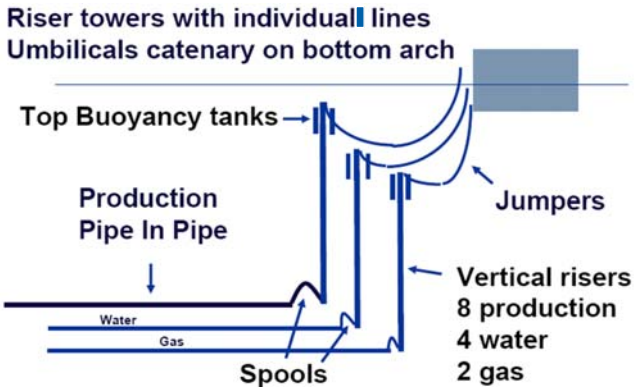
Proposal N°1



Proposal N°2



Proposal N°3



Process of Design Competition and Call for Tenders

Company's Project team	Each Potential Contractor *under Company's supervision*	Each Potential Contractor	Company's Project team
produces	*produces*	*proceeds to*	*proceeds to*
• Functional specifications • Technical specifications • General Group specifications • Contract draft	• Adjusted specifications • Concept selection	• Analyse their subcontractors' offers	• Comparison of the different concepts • Offer evaluations and clarifications • Contract writing negotiation • Issue a Recommendation to Award
in order to launch	*in order to launch*	*in order to submit*	*in order to award*
Design competition	Quotations	Offers	Contract

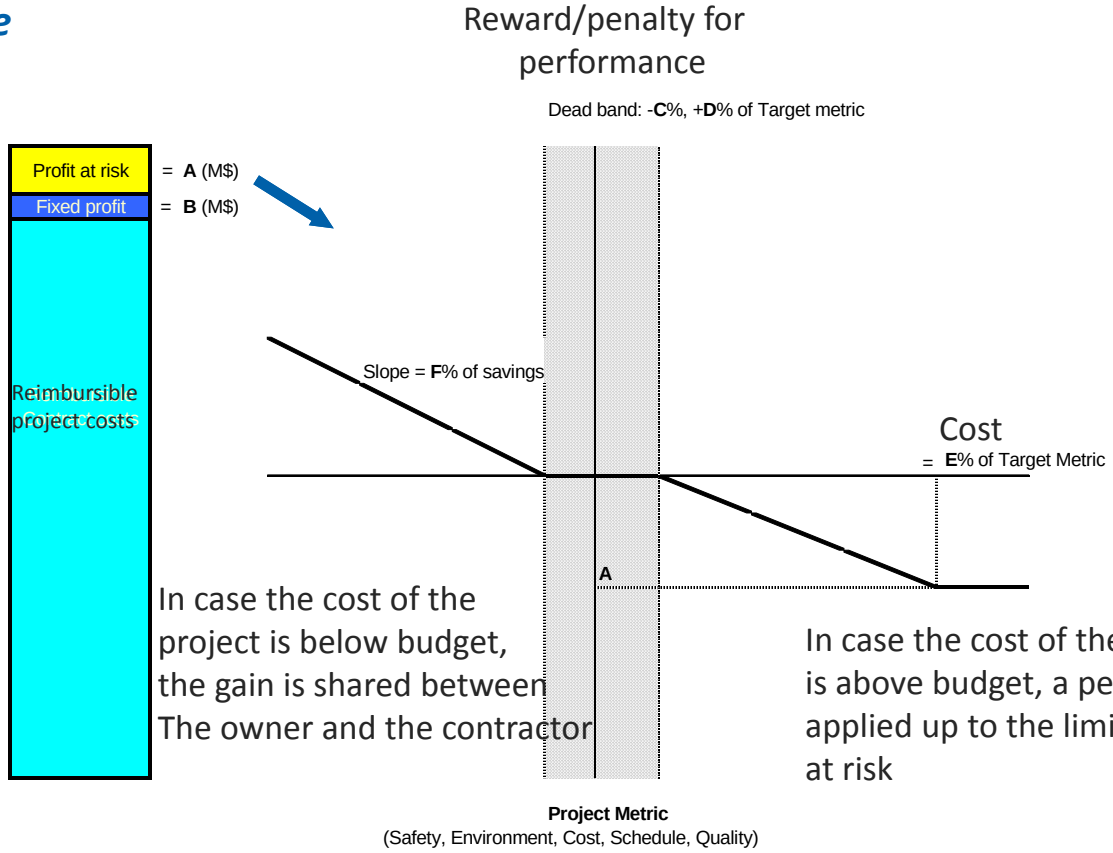
possible recycling

Selecting the right remuneration mode

- **Lump Sum**
  - Pros: clear definition of the work, final price fixed, Contractor's responsibility
  - Cons: long tendering period before contract award, rigidity possibly leading to confrontational attitudes between Owner and Contractor
- **Reimbursable with or without Incentives, with or without target price, Open Book**
  - Pros: quick contract award, global project schedule shortened, flexibility
  - Cons: final price not firm , large Owner supervision team, may be assisted by a PMC (Project Management Consultant)
- **Payment for and on behalf: Purchase orders and sub-contracts placed by Contractor are paid directly by Company**
  - Pros: quick contract award, global project schedule shortened, flexibility
  - Cons: Company directly exposed to Subcontractors and Vendors
- **Open Book (see next slides)**

Risk/Reward contracts

An example



Open Book scheme

- **In case of failure to organise a proper competition due to the lack of bidders (for various reasons) one solution could be to enter in the process of a negotiated bid or Open Book bidding exercise negotiation, for the Main Onshore EPCC contract with the only contracting group prepared to bid**

- **Principles:**
  - One contractor is truly interested in performing the job (they might have performed the FEED)
  - The bid will be prepared in full transparency towards the client
  - The objective will be to agree upon a Lump Sum price for all or part of the scope of work and to sign the contract on this basis, with the objective of reverting to the standard scheme with the usual responsibilities of an EPCC contractor at a later stage

- **In case of failure to agree, schemes minimizing the responsibilities and risks taken by the contractor could be implemented (cost + fee, with or without incentives)**

Open book scheme

- **The decision to enter into an Open Book negotiation has to be approved by all partners involved in the Project**
- **Shareholders are generally encouraged to second personnel into the Evaluation Team and to participate in the Tender Evaluation assessment Team, to be able to monitor the Open Book process as closely as possible and then to be involved directly in the recommendations of the Evaluation team**
- **An Open Book evaluation process enables a profound Technical Evaluation of the Contractor's proposal (more than for a normal competitive Tender) but as such requires full engineering support**
- **Whilst there is only one technical proposal to review, the same effort will be required as that for 2 or 3 competitive proposals: face-to-face discussions over technical issues are more thorough**
- **To be noted as problematic:**
  There is limited incentive for the Bidder to optimise their technical proposal with a view to minimising EPC cost

Open Book Exercise Organization

- **In addition to the standard ITT documents, the Call for Tender will include the following documents:**
  - Bidding Agreement
  - Open Book Rules
  - Open Book Coordination Procedure
- **The operator project team has to develop and submit for Partners approval an Evaluation Procedure for the Open Book tender evaluation**
- **Key features of the Bidding Agreement**
  - Bidder would be compensated for submitting a commercial offer;
  - Bidder would have to endorse the Design Package and submit proposals for Company Early Contract assignment;
  - If successful the Bidder would not be entitled to the compensation;
  - Commitment by Bidder to maintain its team for being responsive to Company's clarification requirement

Examples of Open Book Tenders

- Stockman Onshore
- Ichthys Onshore
- Moho North TLP

Important topics to be addressed

FEED endorsement

- For an EPC contract all tasks regarding the FEED are under the responsibility of the Owner, unless a FEED endorsement is performed
- The endorsement process of the FEED by the Contractor has to implemented with the Contractor preferably at the earliest stage, i.e. during the tendering phase
- However, to shorten the Project global schedule, it may be agreed that the endorsement be performed at the start of the EPC phase, allowing design discussions/change orders at Project start

Important topics to be addressed

LLIs, Critical equipment and CSI

- **Long Lead Items, Critical Equipment and Company Selected Items selection has to be based on very strict objective criteria and limited to:**
  - Equipment that cannot be delivered on time at site if selected and purchased at EPC Contract time (possible examples: LNG Tanks, large rotating equipment, MCHE, extra heavy vessels, pipelines materials…)
  - Equipment requiring rapid specific design finalization to fit the requirement of the project (possible examples: air coolers for an air-cooled modularized LNG Plant)
  - Or equipment that Owner desires to select before EPC Contract Award for "standardization" purpose (example: control systems)
- **For an EPC contract all tasks related to the procurement and the initial steps of the supply of the LLI remain under the responsibility of the Owner, unless endorsed by the EPC Contractor**
- **The endorsement process of the LLI and Critical Equipment by the Contractor has to implemented at the earliest stage with the Contractor, i.e. during the tendering phase**
- **Note: LLI and Critical Equipment will be further described in the Procurement chapter**

Important topics to be addressed

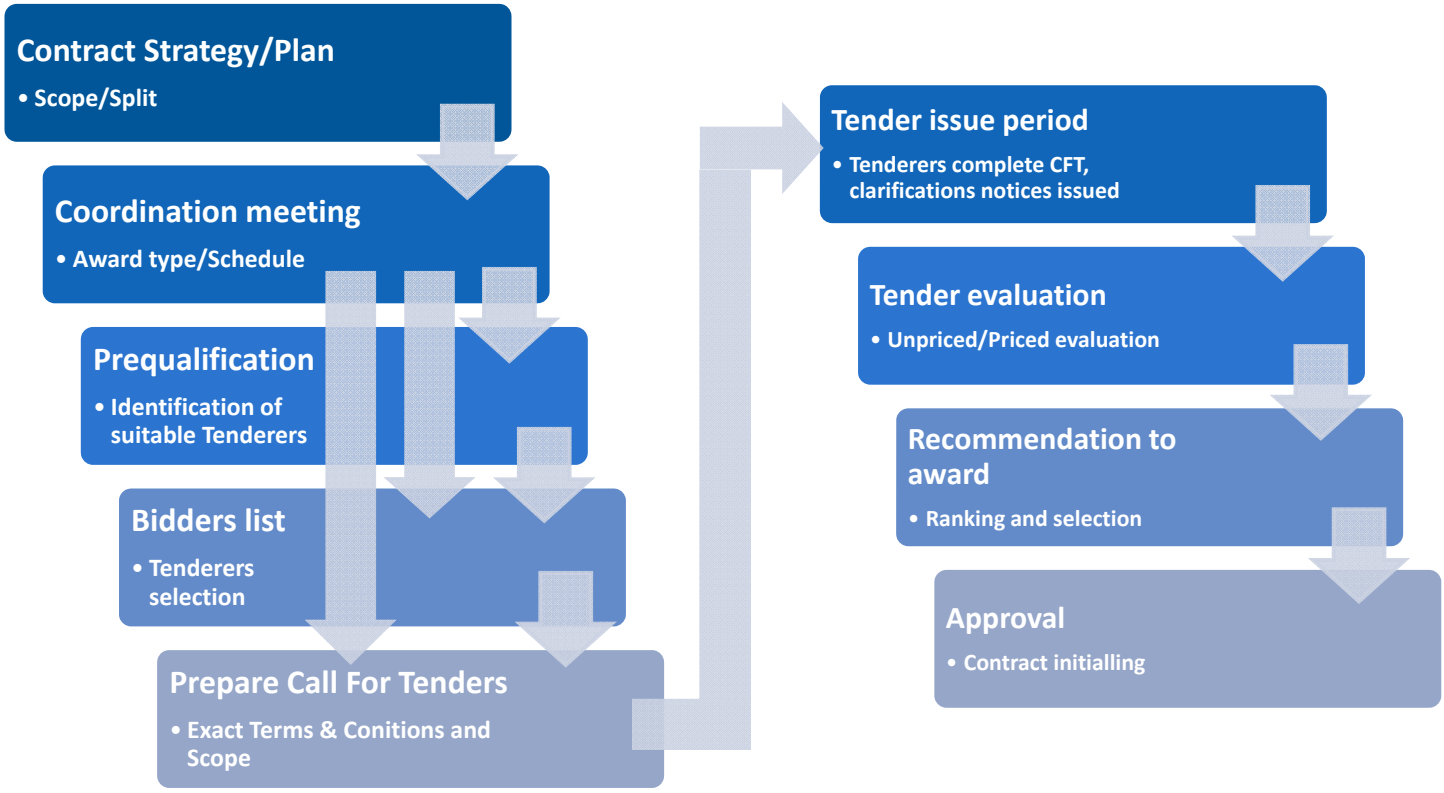
Endorsement of process licensors packages

- **The Process Licenses Contracts are usually contracted by the Owner during the early phases of the Project (pre-FEED or possibly FEED)**
- **For an EPC contract the Process Licensor Contract (BEP and performance guarantees) remain under the responsibility of the Owner, unless endorsed by the EPC Contractor**
- **However EPC Contractors are reluctant to endorse the Process Licensors Guarantees**

Technical contracts

- About Contracting activities
- Planning Contracting activities
- Selecting contract format
- **Contracting process**
- Bid preparation by tenderers
- Contractor selection

A complex tendering phase to award an EPC Contract



Prequalification of tenderers

- Pre qualification of the potential contractors is a review of contractors experience and organization, possibly with a visit of contractors facilities
- Verification that contractors have sufficient competence and resources available for the Project
- For large projects, finding enough competent contractors to ensure competition might be a problem
- Tenderers with competence in different areas, may form a joint venture or a consortium; they may also do so in order to limit the risks associated with large Projects
- Prequalification might be performed through a public advertisement (an obligation in several parts of the world)

Points to be investigated during pre qualification

- Contractor has understood company needs
- Technical capabilities for the work
- Risks associated with awarding the contract to this entity
- Level and quality of management and technical resources
- Proposed technical approaches for the work
- Acceptance of warranties for the work
- Financial capacity
- Production capacity
- Past performance for similar works including HSE performance
- References for similar jobs
- Intellectual property rights for the work processes or services
- Proprietary rights for works, services provided for the project

Objectives of the Call For Tenders procedure

- **To ensure a fair and equitable treatment of all tenderers in order to give them same access to the information**
- **To select a competent contractor after an open competition so that the owner obtains the best acceptable conditions**
- **To ensure that the successful tenderer will have a complete knowledge of the dossier and will not plead ignorance to dispute the validity of the contract partly or totally**
- **It is possible to organize a pre-bid conference during which all potential contractors are gathered and receive the same level of information through presentation by the Owner and questions sessions with the contractors**

Call for Tender documents

Call for Tender =

Instructions to tenderers (introduction & instructions) + Agreement & annexes (terms & conditions) + Exhibits (scope & requirements)

EXHIBITS (Scope & Requirements)

- **Exhibits should – at least – cover mandatory Company's requirements such as**
  - Scope HSE requirements
  - Schedule of Prices
  - Work Time Schedule
  - Performance Guarantees
  - Design Dossier
  - Particular Conditions
  - Quality
  - Company Items
- **They could also give specific requirements and information such as**
  - Coordination Procedure
  - Subcontractors & Vendors
  - Contractors expected Organization

Contract payment terms

- **Payments can be either on a progress basis or on a milestone basis**

  - On a progress basis

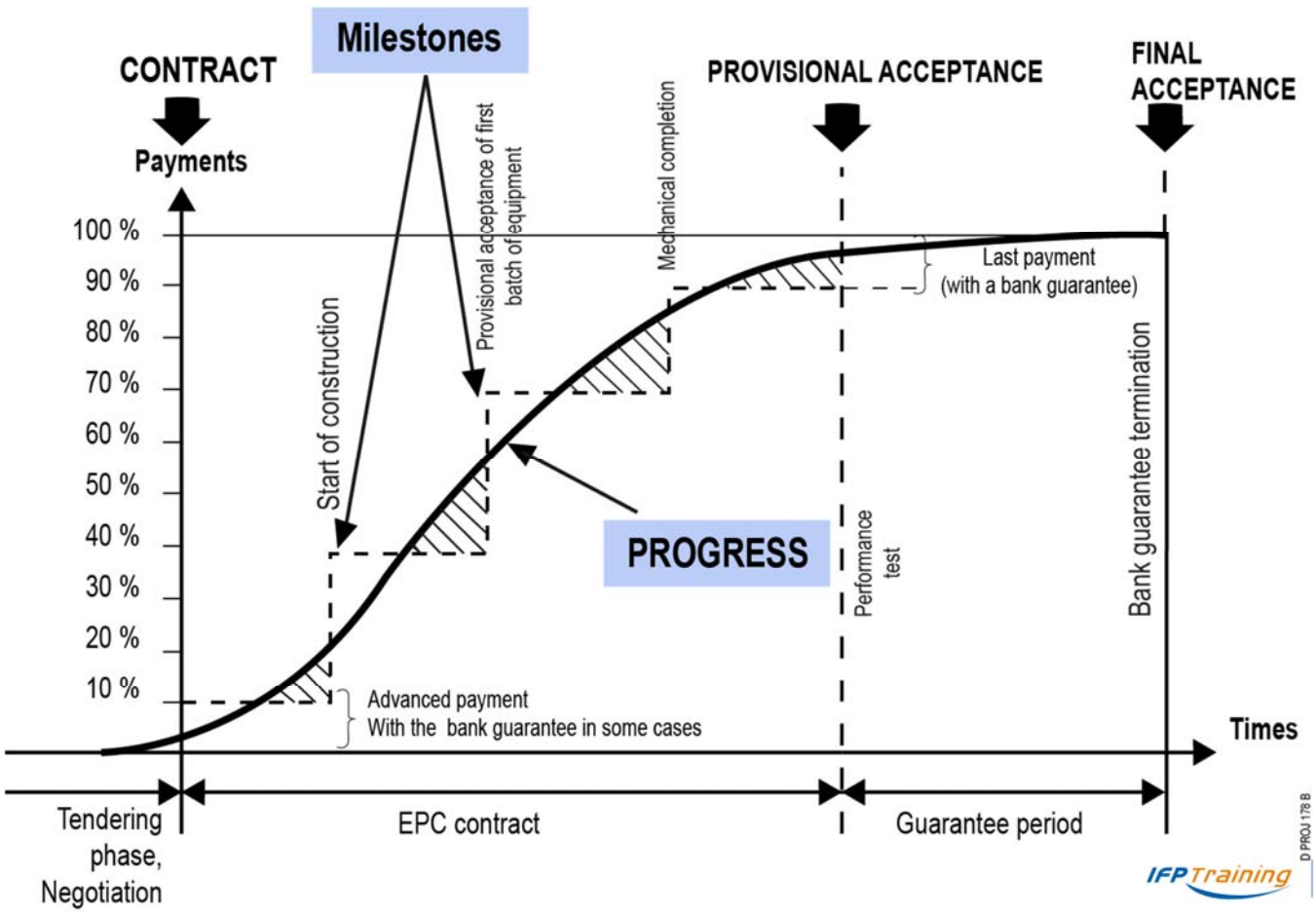
    The contractor is usually paid every month on the basis of the progress of the work which has been achieved during the month

  - On a milestone basis

    The contractor is compensated through a limited number of payments, each being conditional to the satisfaction of predefined criteria or events in relation with the performance of the work

  - On both

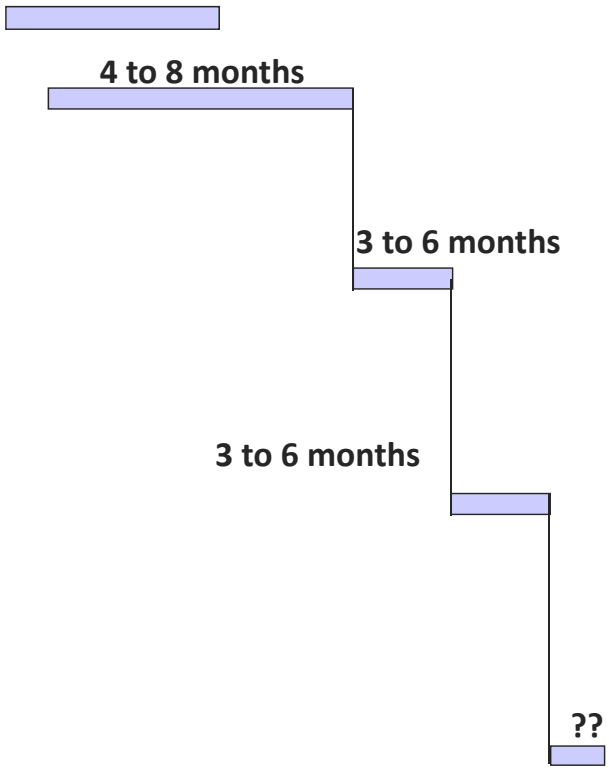
Progress payment and milestones payments



Contract remuneration – Payment on progress

- **Advantages of the progress method for the operator:**
  - The contractor is encouraged to pay a serious attention to the measurement and to submit realistic progress figures to limit the risk of payment delay.
  - The contractor is paid in accordance with the work performed.
  - The approved monthly progress figures quickly allow at any time an estimate of the value of the work performed in case of work suspension or contract termination.
  - This allows the operator a more efficient monitoring of the work time schedule through the checking of the compliance of the performance of the work with the reference “s” curves.
  - It only requires a good “progress monitoring” without needing an army of quantity surveyors.

Contracts tendering typical durations



- **Prequalification of potential Tenderers**
- **Preparation of the call for tenders (by Owner)**
  - Conditions for tender preparation & issue
  - Contract conditions (clauses, prices, etc.)
  - Scope of work and specifications
- **Tenders preparation (by Tenderer)**
  - Issue tender bulletins – Request for clarifications
  - Price preparation (critical path)
  - Technical and Unprized commercial
  - Priced Commercial
- **Tenders analysis (by Owner)**
  - Receipt and formal opening
  - Comparison
  - Clarification meetings
  - Additional submissions
  - Evaluation and recommendation
- **Decision**

Tender period

- A reasonable tendering period shall be allowed taking into account the project schedule and the amount of work of Tenderers are required to perform to complete the CFT
- Any extension request for the tendering period shall be subject to approval; if such extensions are granted, all Tenderers shall be informed by means of a Tender bulletin
- Tendering costs incurred by Tenderers in connection with the bidding process shall normally be borne by the Tenderers and this principle made clear in the CFT documents; however, the project may consider compensating unsuccessful Tenderers for the cost of tendering in certain circumstances (e.g. in the case of major EPC Contracts)

Technical contracts

- About Contracting activities
- Planning Contracting activities
- Selecting contract format
- Contracting process
- **Bid preparation by tenderers**
- Contractor selection

Drivers for Contractors to bid as a group

- **Contractors are invited to tender by Owners according to their capability versus Project requirements, their interest in the Project, results of pre-qualification by Owner, etc.**
- **Owner sometimes shows their interest to see some Contractors gather to bid**
- **For small and medium Projects, Contractors might bid alone**
- **For large and mega Projects, Contractors usually gather in order to**
  - Devote an acceptable portion of their resources to the Project
  - Share Project risks when Lump Sum in a reasonable portion vs their revenue
  - Provide an offer with a work split, which covers Project required areas and brings required qualifications and past experience in terms of technology, required scope, in-country knowledge, knowledge of Owner processes, past similar projects, etc.
- **For Oil & Gas Projects they may group**
  - In Joint Ventures (e.g. LNG, Large Gas Plants…)
  - In a Consortium (e.g. offshore Project requiring a construction yard)
  - With a Nominated Subcontractor (e.g. construction contractor…)

Proposal tasks & proposal content

- **When the CFT is structured per international practice for major projects, other tasks include:**
  - FEED review/endorsement; CFT review
  - Preparation of clarification requests (follow format and watch dead line)
  - Bulks MTOs and estimate of MTO allowances
  - Preparation of requisitions and inquiries to Vendors, technical & commercial evaluation
  - Proposal Executive Summary

Proposal tasks & proposal content

- Technical Offer preparation with, in general:
  - FEED endorsement report
  - Project Execution Plan (Engineering, Procurement, Construction, Commissioning, Project Controls, Materials Controls, Systems etc.), Schedule
  - Technical qualifications
  - Proposal Forms
  - A mandatory principle is to strictly answer to required proposal formats in the ITT
- Commercial Offer preparation with, in general:
  - Prices and Price breakdowns
  - Unit prices and rates
  - Payment Conditions
  - Commercial qualifications
  - Bid Bond
- CFT Agreement review and Legal qualifications
- And, if required, financing proposal

Major components of the bid response

- **Program of work and list of deliverables**
- **Schedule baseline**
- **Performance reporting**
- **Organization charts - Roles and responsibilities of the key personnel**
- **Contractor place of performance**
- **Pricing format**
- **Payment terms**
- **Place of delivery**
- **Inspection and acceptance criteria**
- **Warranties**
- **Product support**
- **Limitation of liabilities**
- **Fees and retainer**
- **Penalties**
- **Incentives**
- **Insurance and performance bonds**
- **Subcontractors selection and control principles**
- **Change requests handling**
- **Termination clauses and procedures for conflict resolution**

CAPEX estimate & estimate methodology general

- Contractor CAPEX estimate is prepared according to the WBS.
- Desired accuracy is -0% + 5%.
- Construction cost is the most important cost item and the most difficult to estimate.
- CAPEX estimate prepared with a memorandum underlying assumptions, estimating methodology, uncertainties and risks.
- A CAPEX « risks » analysis can be done (based on probabilistic – Monte-Carlo methods) to estimate the « probability » of the CAPEX estimate.
- Estimating methodology principles are presented on next slides.

Cost estimate by bidder (1/2)

Cost Item	Cost sub-items	Estimating Method	Comments
Engineering mhrs		Mhrs ratios per equipement	For cross-checks
		Mhrs for similar units	
		Mhrs estimates by engg dept	
Equipment	Main equipment/packages (70% of equ. Cost)	**Requisitions , enquiries for Vendors offers**	
	Special equipment	**ditto**	
	Regular Equipment	Estimating data base / methods	**Consider Vendor Offers**
Bulks	Piping quantities	Factored by ratios for similar units	
		Factored by ratios for equiment	
		Estimating MTOs	Valves above 2"
		BOQs	CS piping lengths ; fittings by ratio
			SS lengths & fittings
			Consider Complete MTOs
	Piping unit costs	Cost data base : standard piping	**Consider Vendor Offers**
		Vendors offers : special items (e.g large, SS valves)	
	Structures quantities	Ratios per volume or other base	Used for cross-checks
		Quantities from similar units	
		Estimating MTOs ; BOQs	
	Structure cost	Cost data base	
		Consider requisitions , enquiries for Vendors offers	

Cost estimate by bidder (2/2)

Cost Item	Cost sub-items	Estimating Method	Comments
EPC packages	LNG Tanks	Vendors offers	
Examples	Ports	Specialized Contractors offers	
Construction supervision mhrs	Construction Dept estimate	Detailed Mobilisation chart	
		% of construction mhrs for similar project	for cross-check
Civil quantities	Foundations	Factored by ratios from equipment weight	For cross checks
		Factored by ratios for similar units	
		Estimating MTOs ; BOQs	
Commissioning supervision mhrs	Commissioning Dept estimate	Detailed Mobilisation chart	
		% of construction mhrs for similar project	for cross-check
Construction	By trade (civil, piping , erection, etc...)	Quantities x mhrs ratios per quantity x all-in mhrs cost	
		Mhrs : stdd mhrs x productivity	
	Mhrs ratios or "yields"	Data Base : standard mhrs	
		Data Base : "productivity" = local mhrs / std	
	Mhrs local cost	Data base	
		Inquire to Constr.Contractors	Close evaluation of Contractors Bids; Clarification meetings with Contractors
Fabrication @ yard; regular offshore producing platform		Mhrs ratios / module weight and /or volume	
		Mhr cost : very depending upon selected yard	
		Mhr cost : very depending upon selected yard	Consider Partnership

Cost & price development TK contract

- **Allowances are added to quantities for:**
  - « MTO allowance » depending on method supporting documents used for the MTO
  - « Project growth », i.e. what is not shown on available drawings
  - « Extra works » which are required by construction contractors working with unit-rates contracts
- **Vendors quotations are compared and technical contingencies and /or « buy-outs » assessed.**
- **A risks analysis is performed. The cost preparation must be a thoroughly controlled process as there are estimating risks associated to FEED completeness and quality, validity of prices submitted by Vendors and Contractors etc.**
- **Contingencies are considered for project risks and uncertainties**
  - Performance risk
  - Schedule risk
  - Other risks
- **Payment terms are analysed versus planned expenses and exposure risk assessed.**
- **Price review meetings are organized with Contractors and /or JV Partners Management.**
- **Profit is added on top of the calculated cost.**

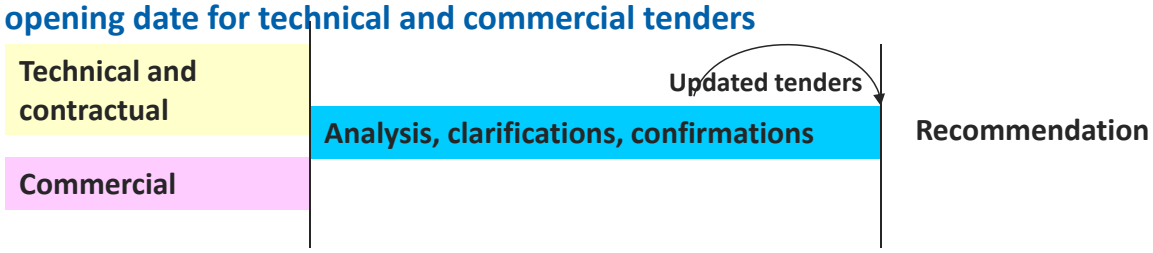
Technical contracts

- About Contracting activities
- Planning Contracting activities
- Selecting contract format
- Contracting process
- Bid preparation by tenderers
- **Contractor selection**

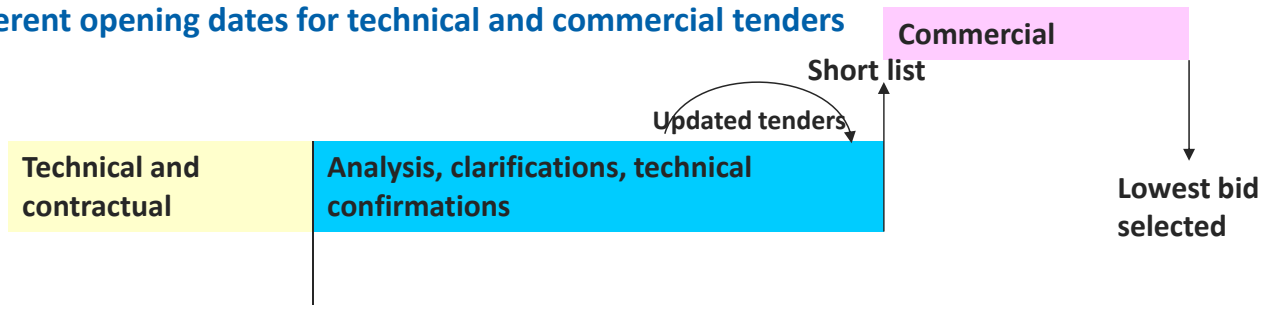
Opening of the tenders

Two philosophies exist for Tenders opening:

Same opening date for technical and commercial tenders



Two different opening dates for technical and commercial tenders



Tender evaluation procedure

- **Responses to the CFT shall be assessed technically and commercially against previously established criteria by a team of representatives of the technical, contractual and commercial functions, co-ordinated by the Owner or PMC**
- **It may be appropriate to include Partner/Shareholder personnel within the Tender Evaluation Team**
- **Organization and criteria of the Tender evaluation must be recorded and approved in a contract specific Tender Evaluation Procedure which shall contain details on the evaluation**
- **Project should give careful consideration to opening only the technical packages first, in order to identify and discard tenders that are not technically acceptable**

Clarification meetings

- **Clarification meetings allow the Owner to review and clarify with each Tenderer**
  - The Contract **execution plan** submitted by the Tenderer, including the work time schedule
  - The **qualifications** and the **alternatives** that the Tenderer submitted with their tender
  - Their reaction to the **acceptable qualifications** or **suggestions** made by other Tenderers
  - Their position vis-à-vis the **endorsement** of the FEED and of the LLIs
- **The clarification meeting will enable**
  - The Owner to **appreciate the understanding and motivation** of the a Tenderer
  - The Tenderer to improve their **understanding of the Owner's position**
  - The Owner to **improve the general quality of the dossier** by taking into account the relevant comments

Local Content evaluation

- **Tender content**
  - Identify proposed Local content
  - For each package, check that the contractor clearly indicates in dedicated tables the LC quantities (Tons, man-hours, etc.)
- **Clarify and quantify LC during tender evaluation**
  - Compile LC dossiers in each package extracted from data supplied in technical tender submissions
  - Estimate the cost differential between LC price as tendered and comparable market price for equivalent scope
  - Undertake gap analysis in terms of cost, schedule and risks in order to allocate committed level of LC into the overall assessment procedure of the bidders
- **Confirm the viability of the LC plan included in the EPC contract through organization, site visits, manpower assessment**

Normalization of tenders

- **The commercial evaluation (priced proposals) may include the following tasks**
  - Arithmetical verification of the Lump Sum, Provisional Sums and Options
  - Normalization of Tenders, taking into account such cost items as:
    - Company supervision differential cost due to remoteness of Tenderer working sites
    - Company estimate for items not quoted for by Tenderers
    - Company estimate of possible exclusions or limitations presented by Tenderers
    - Company estimate of cost differential due to different Tenderer schedules
  - Comparison with Company cost estimates
- **The comparison between tenders will then occur based on the initial contract price with normalization, unless specified otherwise by the Operating Agreement**

Opening of final tenders and selection of the Contractor

- **After having checked that each tenderer has accepted (by initialling every page) Contract conditions, the Owner opens the commercial proposals**
- **The selection is made in principle on the lowest price basis**
- **If it is not the case, the Owner is usually requested to document his decision (e.g. by presenting the detailed scored evaluations)**
- **Accepting a last minute uncontrolled price reduction by one contractor out of the normal competitive procedure would be**
  - Unfair to the other Tenderers (and counter-productive for following project)
  - Risky, as the Contractor will probably try to recover such reduction during the execution of the Contract

Project contracting

- **Contracting strategy definition is based on a thorough analysis of the project scope, markets, available resources, risks and stakeholder's requirements**
- **A contract defines not only the program of work and the financial remuneration mechanisms but most importantly how the risks are shared between the parties**
- **The pre-qualification exercise should eliminate companies not having the required competencies or resources for the work**
- **In case of insufficient competition or complex scopes, an open-book contract scheme can be considered**
- **The contract evaluation criteria and weighting factors must be established by the Owner prior to issuing the tender**
- **The contracting strategy will generate interfaces between different contracts which represent a significant risk area (cost and planning)**



Organization

Project Organization

Foreword

- **Main objective**
  - To define the right structure to organise the team that will carry out the project

- **Main tools and means**
  - Typical organization charts

Project organization

Organizational influences in project organization

Typical Oil & Gas projects organizations

Specific aspects for large EPC projects

The project manager competence and skills

Organizational influences on Project Management

1. Project culture and management styles

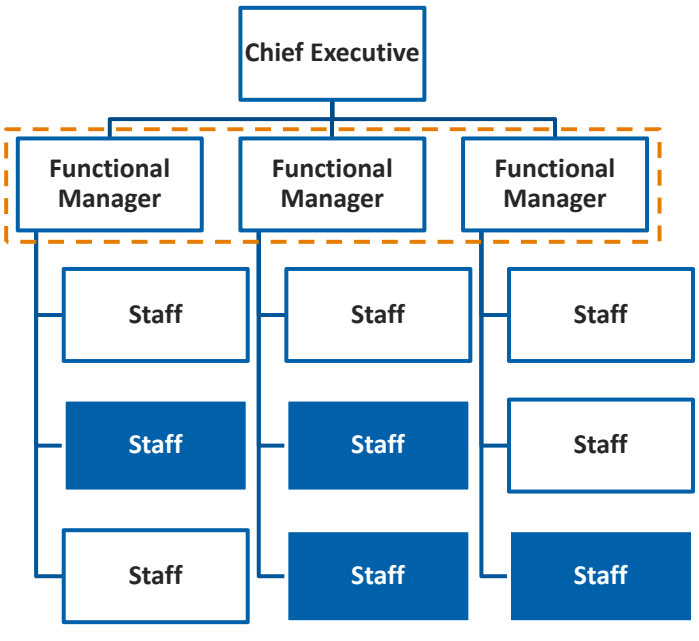
- Any organization has its own culture and this influences how project are organized and executed
- E&P projects most of the time involve several organizations which have different cultures
  - Contracting in different countries
  - Joint ventures or partnering agreements
- To conduct major projects, organizations will partly rely on external resources integrated into their teams
  - Contractors come with their own culture

2. Typical organization structures

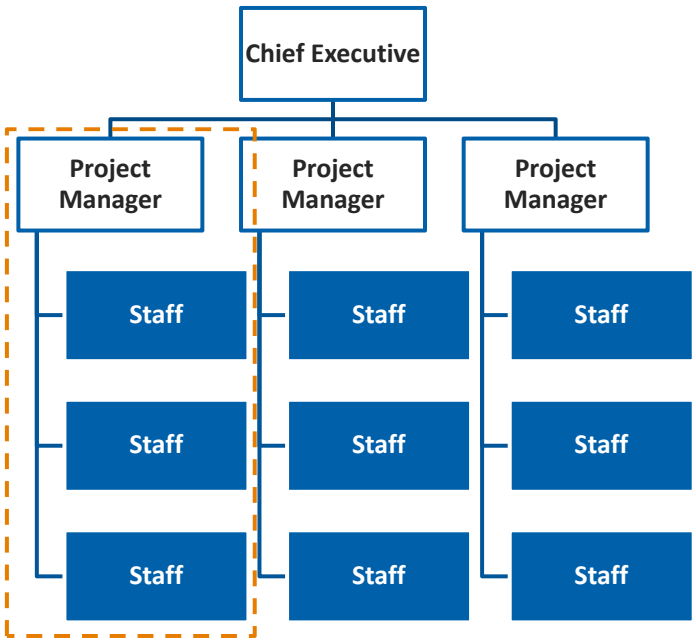
- Functional organization
- Weak matrix organization
- Strong matrix organization
- Projectized organization

Typical organizational structures

Functional organization



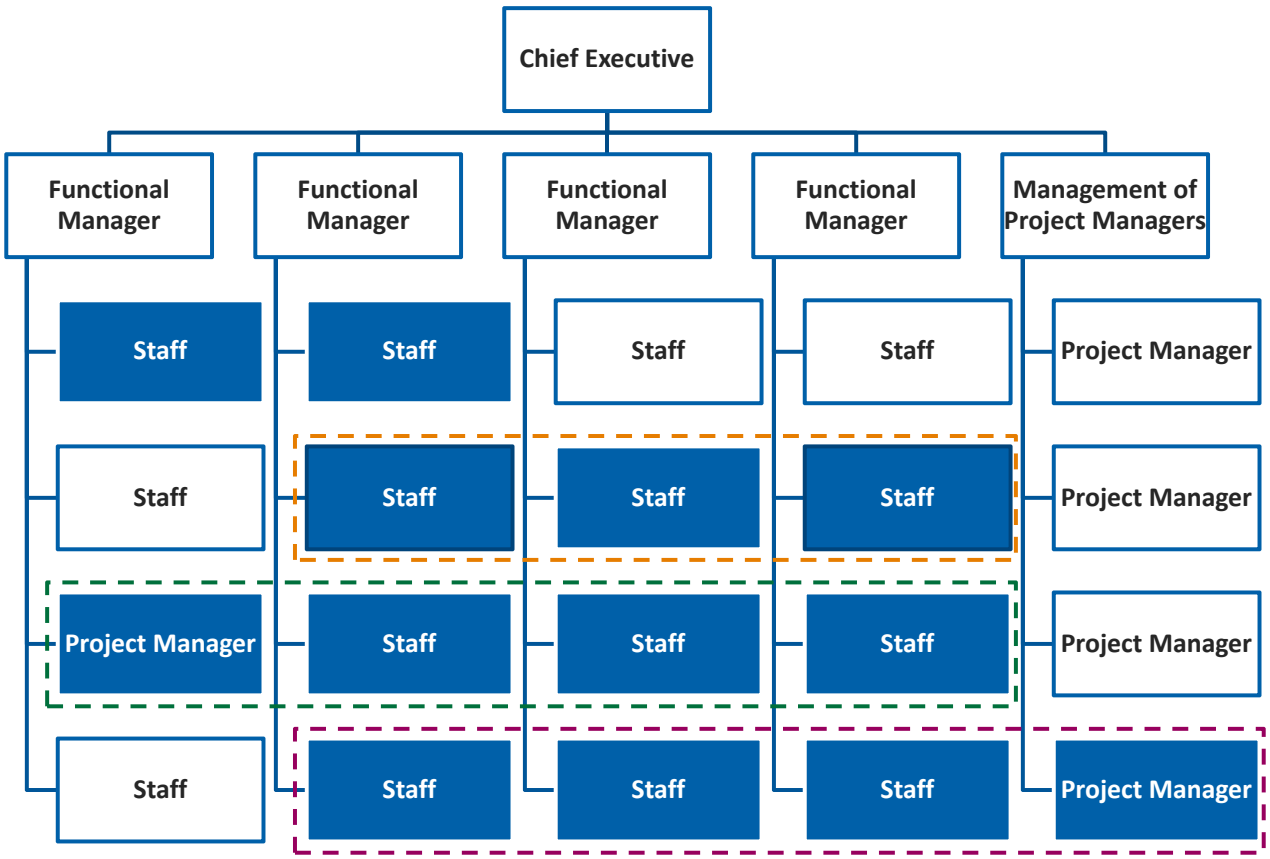
Projectized organization



Project coordination appears in orange

Typical organizational structures

Matrix organizations: weak, balanced and strong



Influences of organizational structures on projects

Organization Structure / Project Characteristics	Functional	Matrix			Projectized
		Weak Matrix	Balanced Matrix	Strong Matrix	
Project Manager's Authority	Little or None	Low	Low to Moderate	Moderate to High	High to Almost Total
Resource Availability	Little or None	Low	Low to Moderate	Moderate to High	High to Almost Total
Who manages the project budget	Functional Manager	Functional Manager	Mixed	Project Manager	Project Manager
Project Manager's Role	Part-time	Part-time	Full-time	Full-time	Full-time
Project Management Administrative Staff	Part-time	Part-time	Part-time	Full-time	Full-time

How would you describe your Company culture?

Source: PMI

Organizational model selection criteria

1. Factors to be considered

- The strategic importance of the project
- The technical characteristics of the project
- The Organization's background in project management – its own management systems and human resources in project disciplines
- The project contracting strategy
- The geographical location of the actors of the project during the various phases of the development

2. Organization principles

- Organization and contracting strategy are deeply interdependent
- The organization must evolve all along the main project phases as detailed before.
- The organization must suit the responsibilities of the actors of the project (Company, Partners, Contractors, suppliers)

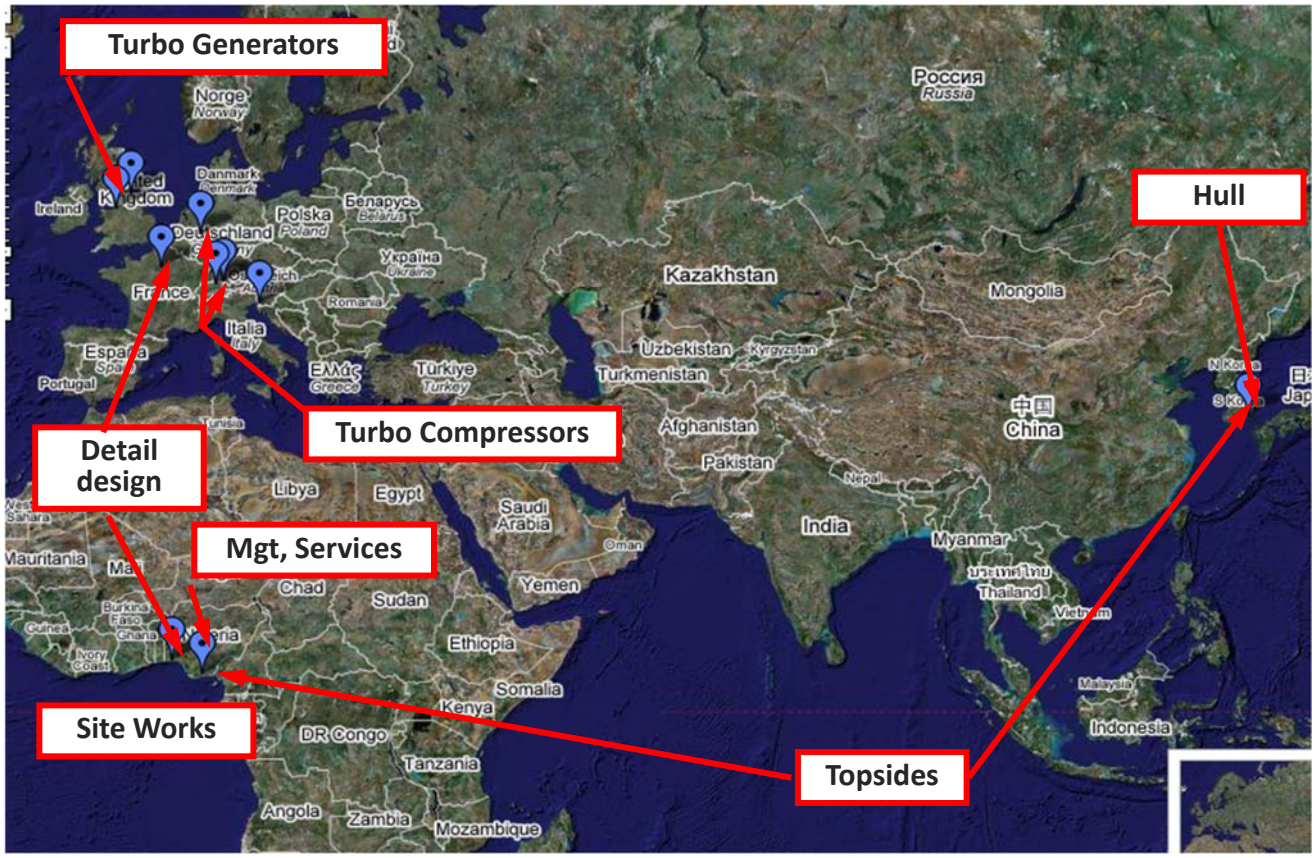
Project organization

- Organizational influences in project organization
- **Typical Oil & Gas projects organizations**
- Specific aspects for large EPC projects
- The project manager competence and skills

Company project management team

- **Company Project Management Team is located at the centre of gravity of the activities**
  - Main contractor Home Office
  - Then Construction Site
- **As the Main Contractor Management Team also moves with the centre of gravity**
  - Typically at 80% of engineering progress
- **Each Work Package Manager and his team is located at or as close as possible to the relevant**
  - Work Package Contractor Home Office
  - then possibly at Site

Work locations- Ex FPSO package

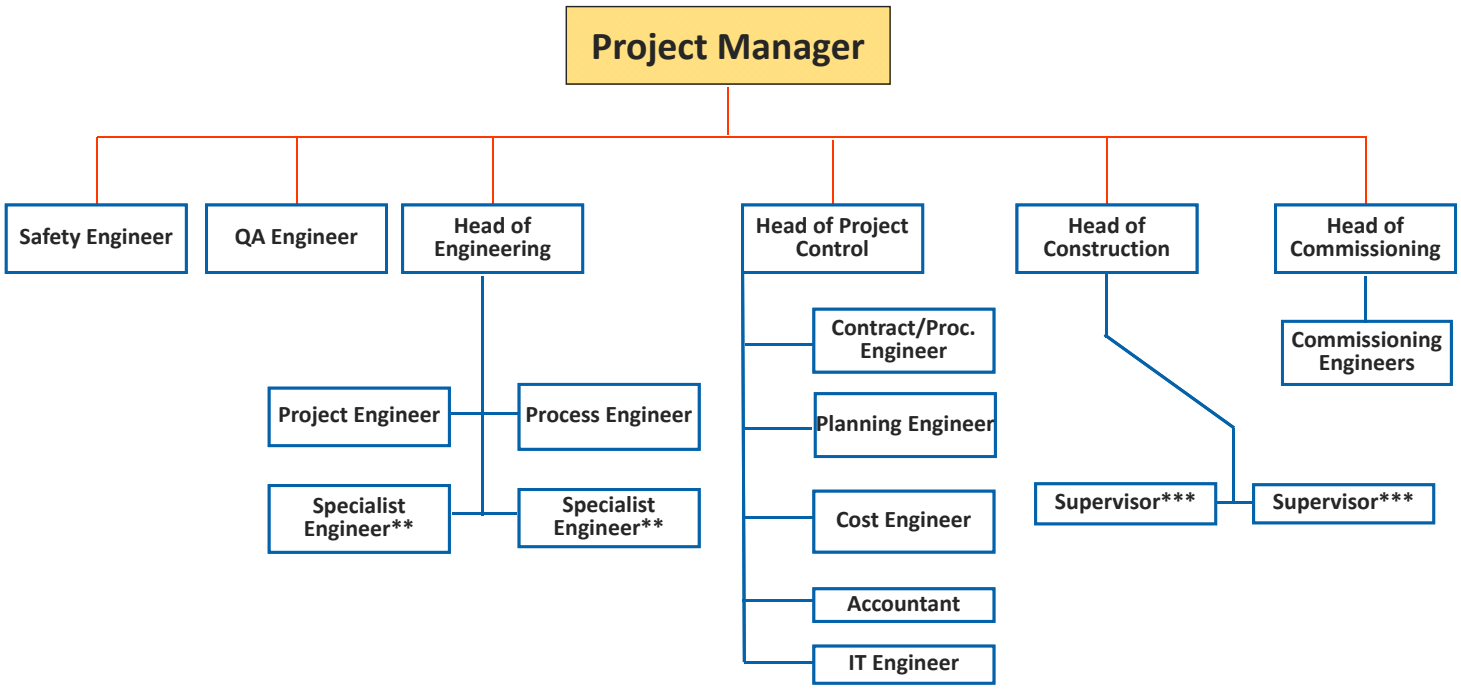


Typical organization charts

- **Four typical organization charts are presented. They are in no case exhaustive but indicate frame of organizations frequently used in projects**
- **The size of the project drives selection of personnel integrated full time in the project team or working part time from its basic organization**
  - QA, HSE, specialists, services, production representatives…
- **The scope of the project organization can include subsurface activities – Geosciences and Drilling– with an 'integrated' project organization**
- **For surface facilities, the project organization may be split either**
  - By function: typically engineering, procurement, construction
  - Or by package: e.g. platform, pipes, FPSO…
- **Choice to be made with consideration to number of main contracts and contractors location.**

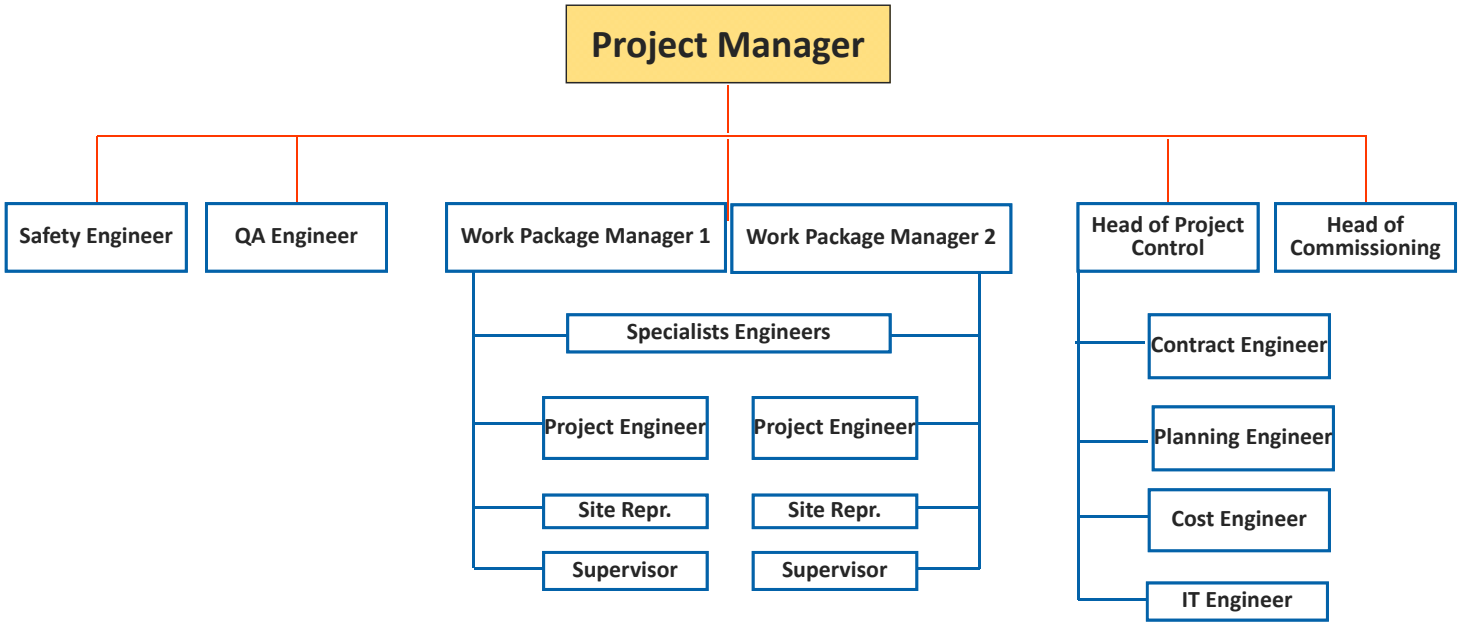
Typical organization small & medium projects

Split per Activities / Disciplines



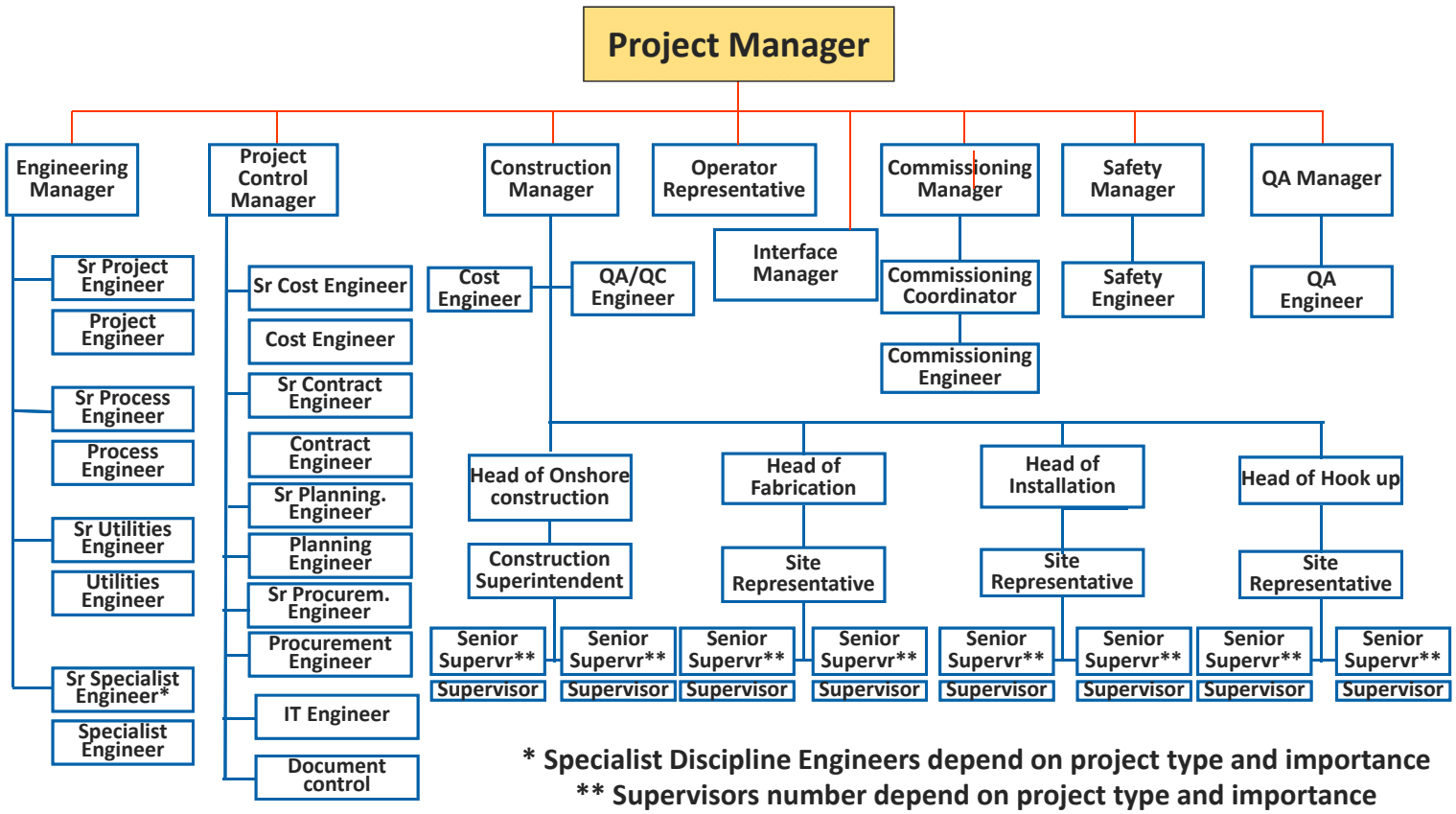
Typical organization chart small & medium projects

Split per Work Packages



Typical organization large projects

Split per Activities / Disciplines



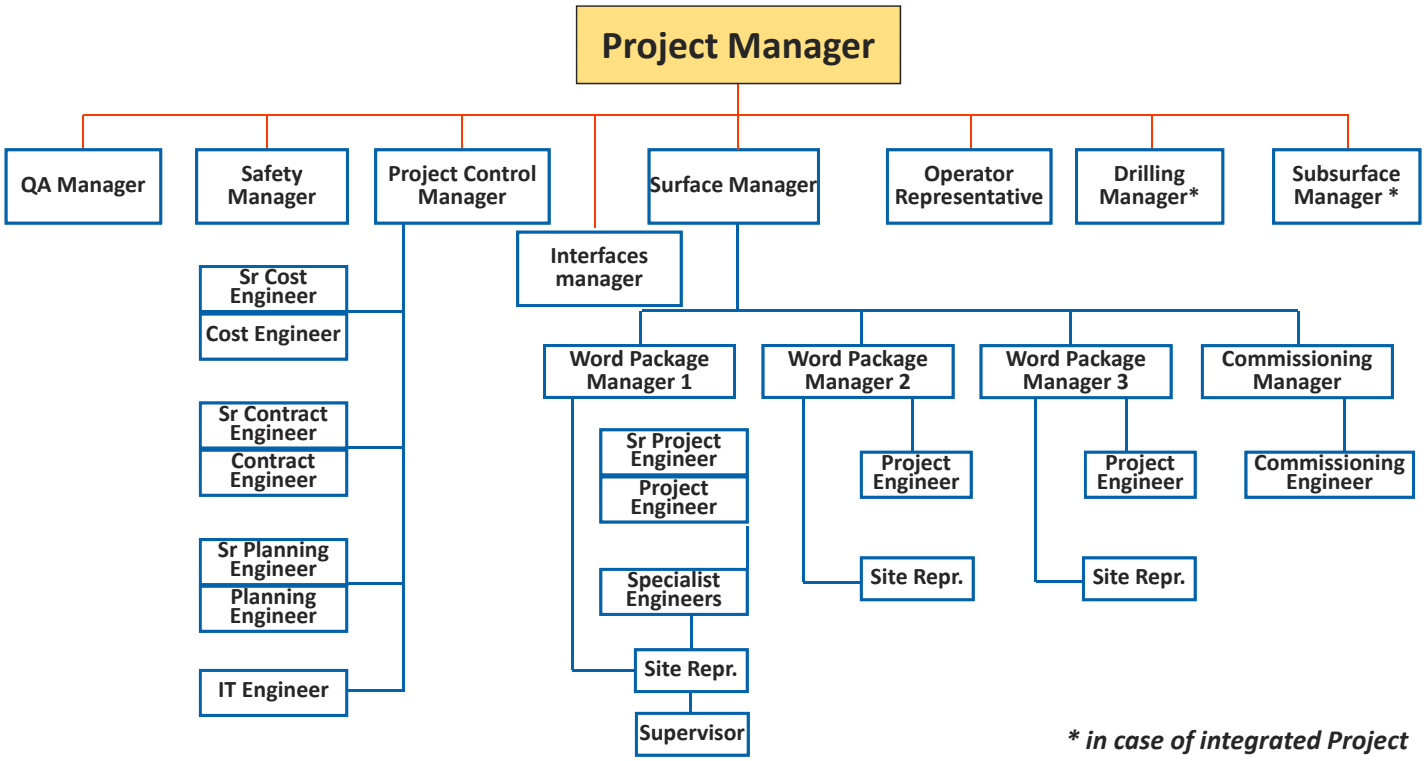
* Specialist Discipline Engineers depend on project type and importance

** Supervisors number depend on project type and importance

** in case of integrated Project*

Typical Organization large projects

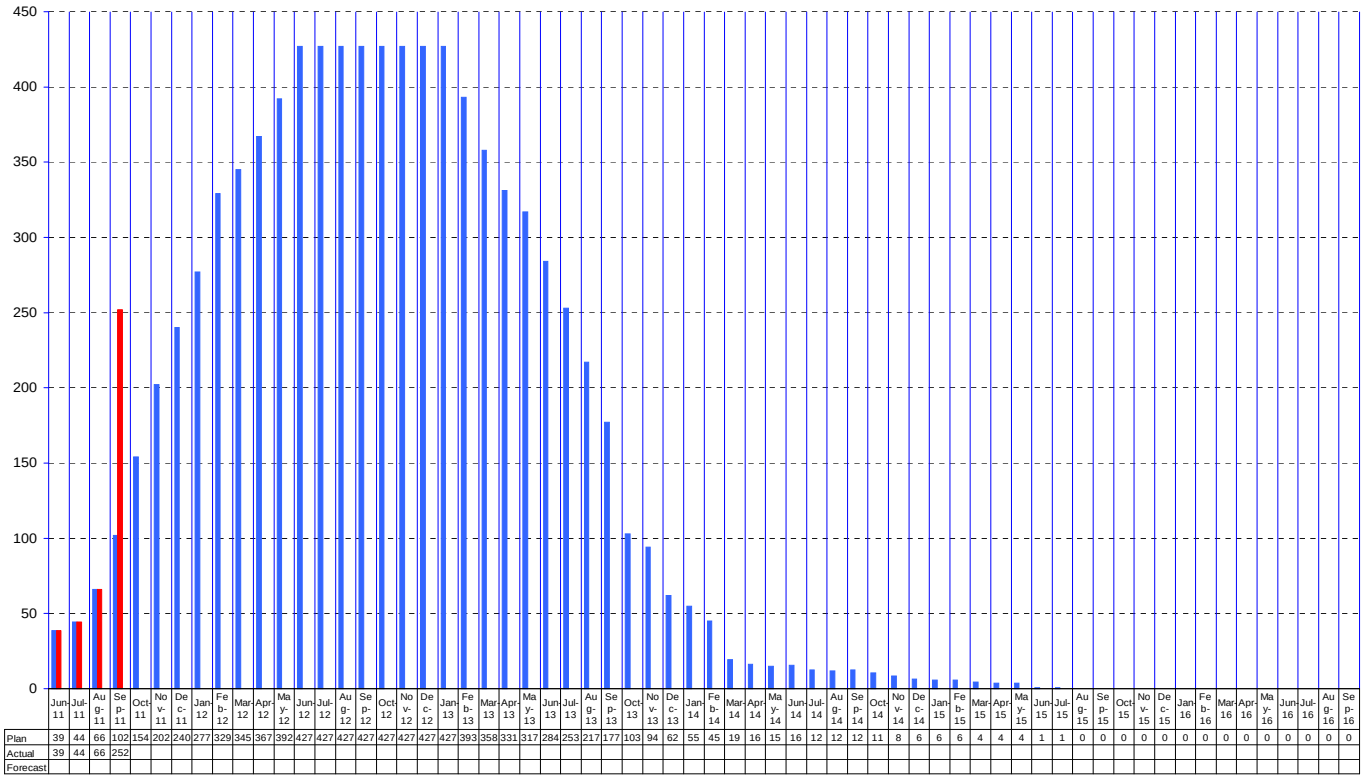
Split per Work Packages



** in case of integrated Project*

Project manning level curve

An example



	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
Plan	39	44	66	102	154	202	240	277	329	345	367	392	427	427	427	427	427	427	427	427	393	358	331	317	284	253	217	177	103	94	62	55	45	19	16	15	16	12	12	12	11	8	6	6	6	4	4	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Actual	39	44	66	252																																																																			
Forecast																																																																				

Project organization

- Organizational influences in project organization
- Typical Oil & Gas projects organizations
- **Specific aspects for large EPC projects**
- The project manager competence and skills

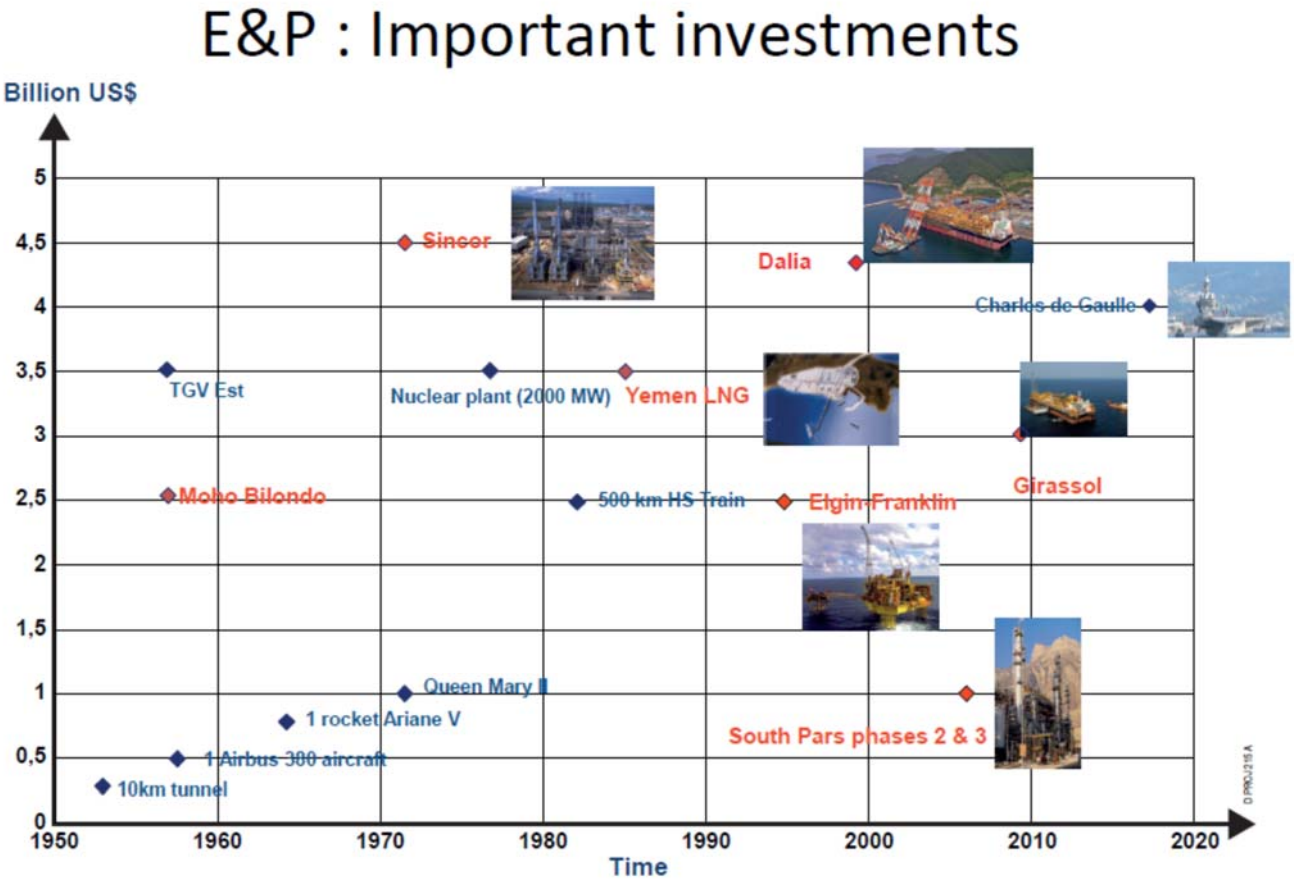
Projects Key figures

Large Projects quantities (Order Of Magnitude)

- TIC (Total Installed Cost) > 1 GUSD
- Engineering man-hours > 1 M mhrs
- Construction man-hours > 10 M mhrs

Mega Projects quantities are several times these quantities
(e.g. 50M construction mhrs)

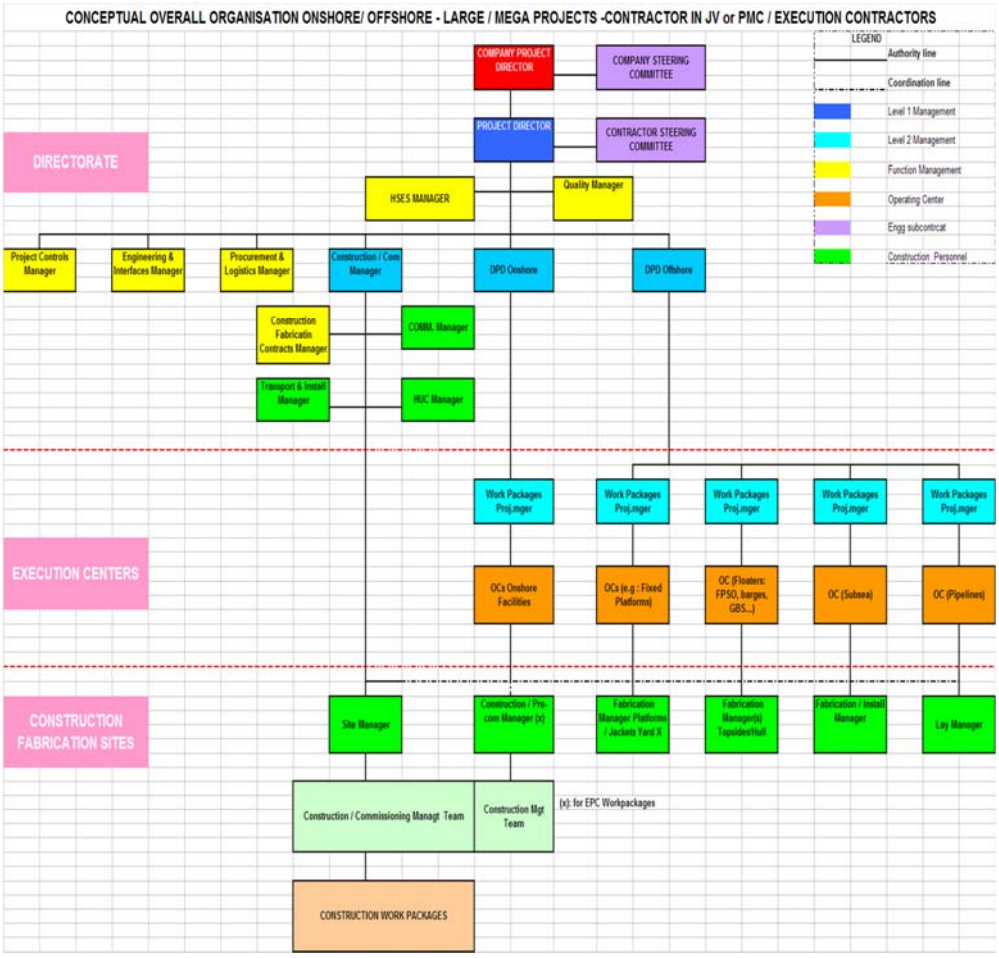
Projects Key figures



Management of multi-company organizations

- **Some large and complex projects require large engineering and construction management teams and workforces and associations of Contractors to bring all skills required for the project; the Main EPC Contractor organization will consider:**
  - Association in a JV or Consortium with a global management overall organization ensuring a single responsibility towards Company, the 'Directorate'
  - Participation of several Main Engineering Offices, 'Operating Centers', and Satellite Offices for engineering and procurement
  - And/or splitting the Project into sub-projects corresponding to work-packages

Example multi-company organization



Contractor organizations

- **For small to medium size projects contractors organizations are similar to the Company ones**
- **Organization by discipline or by package depending on:**
  - The phase of the project
  - The strategic importance of the project
  - The technical characteristics of the project
  - The Organization's background in project management – its own management systems and human resources in project disciplines
  - The project contracting strategy
  - The geographical location of the actors
- **The project organization and will also change as the project moves from the engineering to the construction phase**

PMC contractor

- **A Project split into a PMC Management Contract and Execution Contracts according to the Project Contracting Strategy**
- **Execution contracts on EP or EPC basis**
- **A PMC Management structure, with:**
  - A «Directorate», global management level for Project management
  - Management Teams at offices of Execution Contractors
- **A site organization with a common construction and commissioning organization for EP contracts**
- **The Directorate moves to the Project Country/site when the « centre of gravity of the Project moves to the site »**

Project organization

- Organizational influences in project organization
- Typical Oil & Gas projects organizations
- Specific aspects for large EPC projects
- **The project manager competence and skills**

Project manager competences and skills

- **Knowledge about Project Management**
- **Ability to deliver while applying his PM knowledge**
- **Demonstrate personal and interpersonal skills**
  - Leadership
  - Team building
  - Motivation
  - Communication
  - Influencing
  - Decision making
  - Political and cultural awareness
  - Negotiation
  - Trust building
  - Conflict management
  - Coaching

Summary

- Various models exist for project organizations. The choice for a given project depends its nature and size, its location and the Company project culture
- Organization and contracting strategies are closely interrelated
- The project organization must evolve throughout the main project phases
- The project may have either an “integrated” organization including all its own functions, or a ‘matrix’ organization relying on support from the corporate organization
- Multi-company projects (JV or consortium) require a special management organization with a directorate representing the interests of each company
- The project manager plays a key role in the project success and must demonstrate a number of personal and interpersonal skills



Foreword

Main objective

- Oil & Gas Projects shall be carried out with no accidents and no fatalities
- Oil & Gas facilities shall be designed in a way that no accidents or fatalities during their operation

Main tools and means

- HSE in design
- Hazard identification
- Safety programs with innovative approaches
- Measurement of HSE performance

About Health, Safety and Environment
Planning HSE design activities
Conducting HSE studies
Planning operational HSE activities
HSE reporting
HSE performance improvement

Two aspects in HSE

- **HSE in design**
- **Operational safety**

HSE in design main purposes

- **To create safe and sound facilities, in design, during its construction, and for future operation, through the life of the plant, by**
  - Identifying the hazards
  - Eliminating them, or reducing to minimum potential effect
  - Permitting effective control, avoiding unproven conditions (technology, procedure...)
  - Selecting and implementing the governing References, Norms, Rules and Standards, the relevant Company policies and objectives
- **Main area of application**
  - Safety of personnel
  - Protection of the environment
  - Protection of assets
  - Minimization of damage to company image

Main terms & definitions

- Health: State of being free from illness or injury (common dictionary), achieved through a combination of physical, mental and social well-being (added by world health organization)
- Safety: state of being “Safe” (common dictionary). Being protected from event that causes losses (health or economical)
- Security: degree of protection against actions of people attempting to cause destruction or criminal activity
- Environment: surrounding of an object (common dictionary). The totality of circumstances surrounding an organism, or group of organisms.

Design challenges

- Sound and realistic set of references, policies and goals (Zero risk does not exist)
- Reliable risk assessing processes (data banks, calculation model, accurate data, confirmed procedure, proven concept, new items testing, etc.),
- Experienced personnel for specific analysis (ex: QRA, EIA) to prevent under/over designing requirement

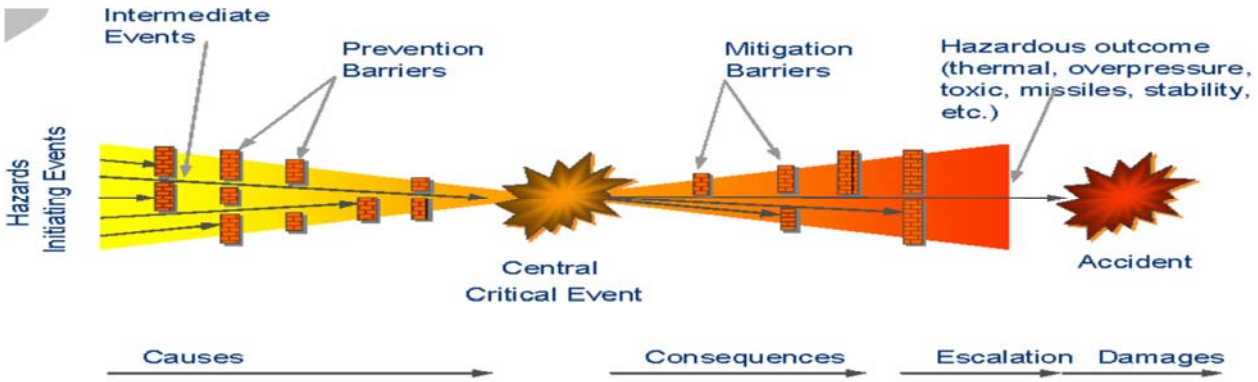
Main terms & definitions

HAZARD

- Existing potential of a compound (e.g. toxic H2S) or working practice (working at elevated place) to cause damage/loss to persons and/or environment (SEVESO II directive).

RISK

- Potential accident due to hazard situation
- RISK level: probability of an accident, of its gravity (ISO/CEI 51)
- RISK value= Probability x Consequences [Severity of Gravity]



Health, Safety and Environment

Technological risks

- Generated by flammable, toxic, explosives substances
- Risks concern individuals, environment, integrity of installations and production, surroundings elements



Occupational risks

- Injuries or fatalities caused by the hazards of the workplace and the nature of the work to working personnel, or surroundings population



HSE management

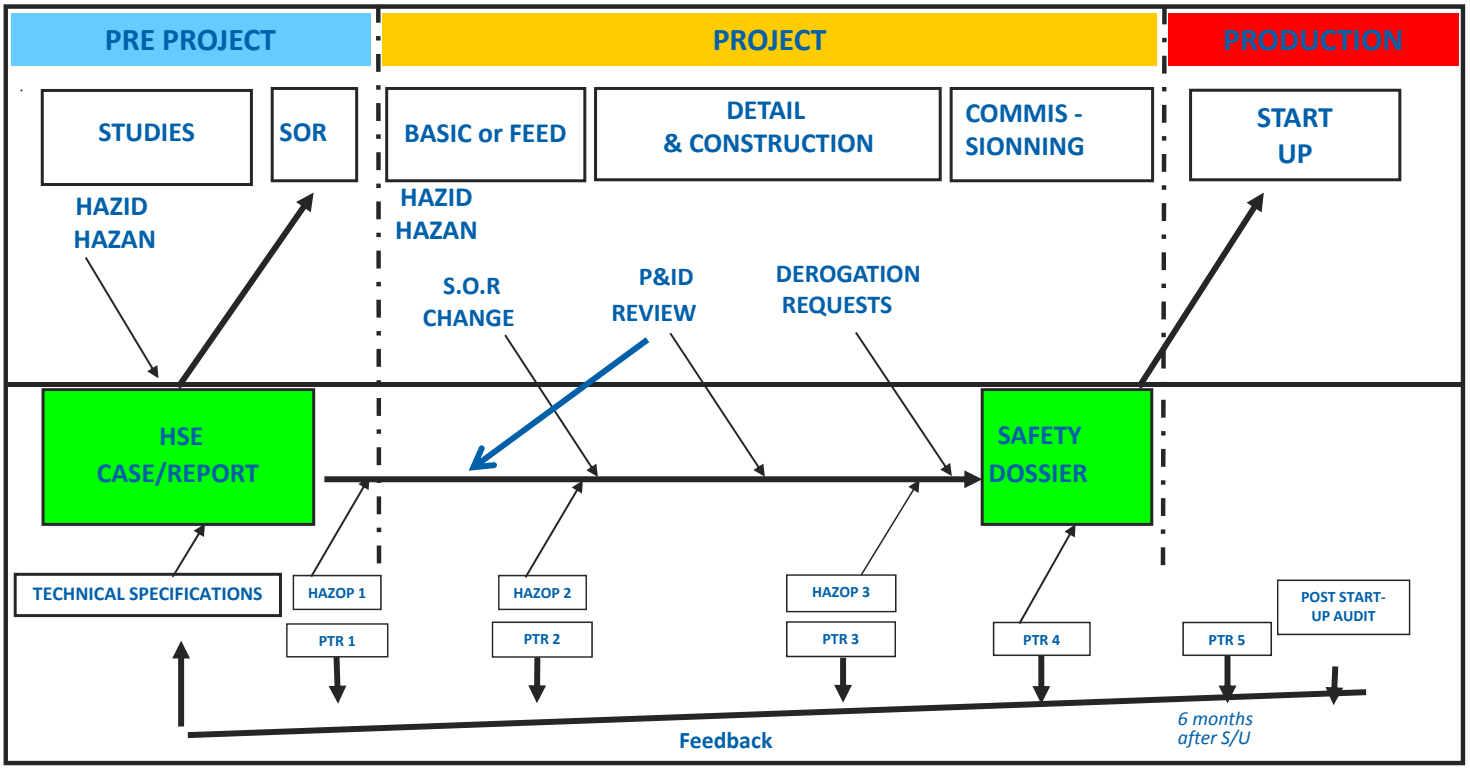
- About Health, Safety and Environment
- Planning HSE design activities
- **Conducting HSE studies**
- Planning operational HSE activities
- HSE reporting
- HSE performance improvement

Reference documents

- **National Regulations**
  - Safety case
  - SEVESO…
- **International standards**
  - API
  - NFPA
  - EN
  - BS
  - IMO
  - SOLAS…
- **Insurance Company rules**
- **Certification and classification body rules**
- **Company specifications**



Safety Studies during project lifecycle

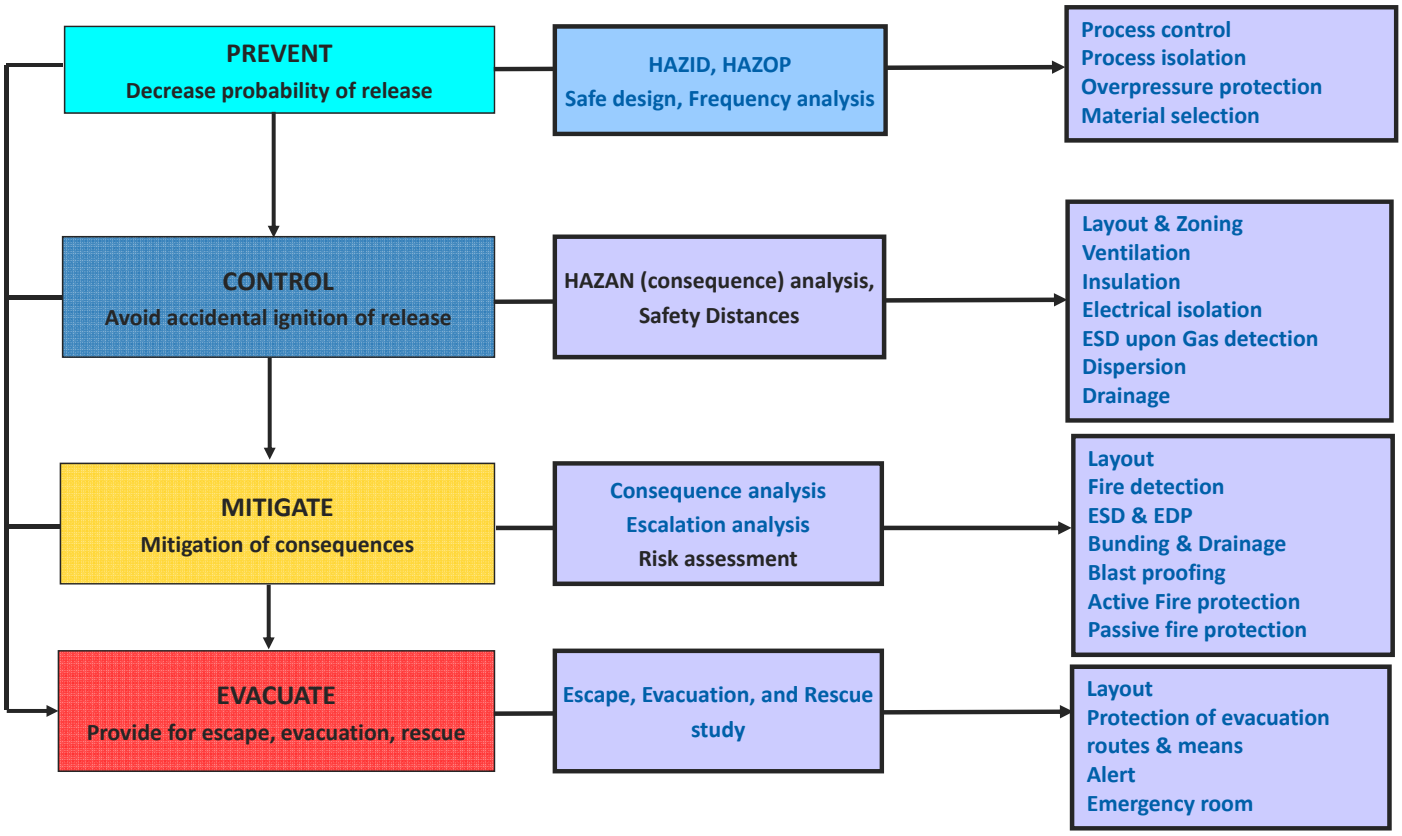


HSE design tools

- **Safety studies**
  - HAZID
  - HAZAN
- **Safety reviews**
  - HAZOP
  - Audits
- **PTR**
- **SIMOPS**
- **Environment**
  - EBS
  - EIA
- **Risks**
  - PRA
  - QRA



Safety by Design: strategy, tools, results

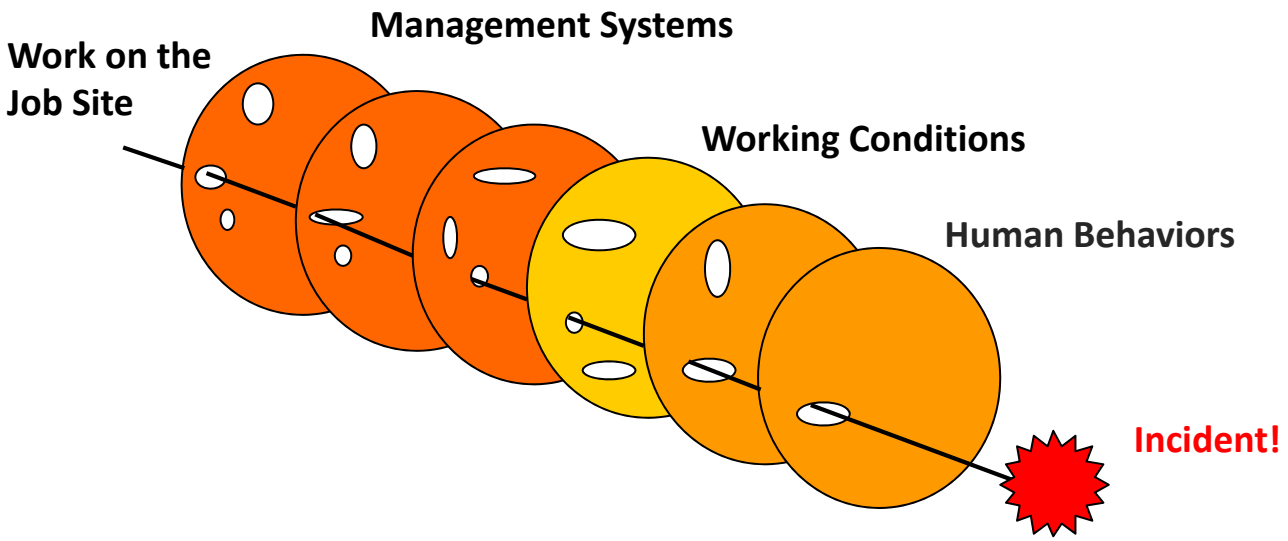


Conceptual and Pre-Project Studies

Environment protection

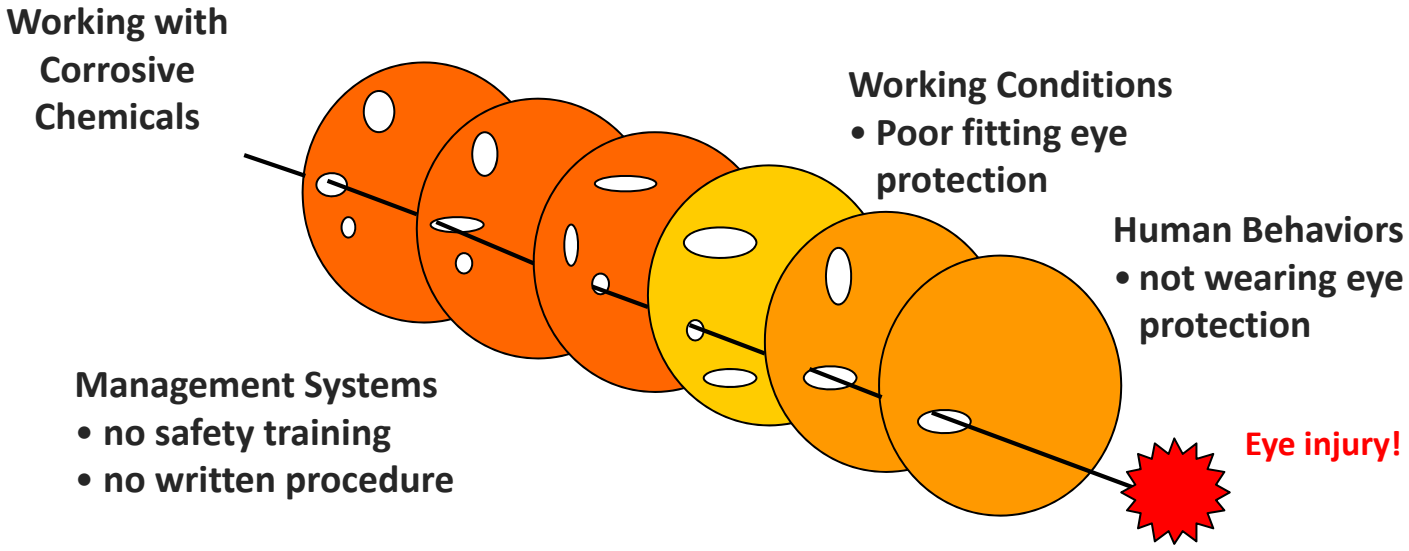
- **Environmental management of the project. Three essential tools:**
  - EBS (Environmental Baseline Survey): analysis of the initial status of the site (reference status for further controls comparisons)
  - EIA (Environmental Impact Assessment): detailed description of the impacts of the projected activities on the site and mitigation measures for reducing these impacts to a level as low as possible
  - EMP (Environmental Management Plan): essential tool dedicated to the Environment preservation during construction and operations, (including Oil Spill Contingency Plan, Waste Management Plan, Chemicals Management Plan, Biodiversity Management Plan, Monitoring, etc.)
- **Other Environmental Risk Assessment and/or Modelling tools:**
  - DREAM: risk analysis for Operational Releases (water effluent, chemicals)
  - Various 3-D Oil Spill Contingency and Response models
  - Various atmospheric dispersion models

Safety filters



Safety filters

Incident example



HAZID (Hazard Identification)

- **Identification of hazards method:**
  - Use of Guide word and prompters list
  - “helicopter” view required, zoom in as necessary
  - Review plant HAZARDS (e.g. blast), from the facilities to the neighbouring environment
  - Review External HAZARDS (natural, other industries, surrounding conditions…) onto the facilities
- **Done, and recorded**
  - Normally once, before end of pre-project
  - Can be complemented by specific HAZIDs on complex subjects
- **Key attitude: openness, rigorousness, thoroughness**

Hazard Identification

Examples of guide words

- **FIRE**
  - Risers…, living quarters (protection of people)
- **EXPLOSION**
  - Sources of ignition, release duration…
- **TOXICITY**
  - Flare switch off, vent, blow-out...
- **SMOKE**
  - Fire in ventilated area, Discharged water…
- **DROPPED OBJECTS**
  - Crane, anchor, sub-sea lines…
- **COLLISION**
  - Truck, vessels, boat landing, FPSO/loading, marine channel
- **AIRCRAFT**
  - Landing path, landing procedures…
- **FISHING**
  - Trawlers, nets…

HAZID (Hazard Identification)

- **HAZID WORKSHEET**
  - CARINA-ARIES OFFSHORE HAZID #1 STUDY.
    Priority Categories: 1. Mandatory (Immediate action); 2. Recommended (Short Term action); 3. To be developed (Long Term action)

N°	SYSTEM / NODE	UNIT / LOCATION	GUIDE WORD	CAUSE	POTENTIAL DEVELOPMENT & CONSEQUENCES	SAFEGUARDS/ CONTROLS IN PLACE	ACTIONS / CONTROLS TO BE INCORPORATED	PRIORITY
12	SUBSEA ITEMS	SUBSEA PIPELINES	EXISTING HIDRA SUBSEA PIPELINES	Construction activities/pipes laying/barge anchoring	Potential damage or rupture of Hidra existing pipelines.	No specific protection to subsea existing pipelines. Physical & electronic surveys to be performed on site to locate and mark existing pipelines.	**Anchor pattern to be submitted to TA marine Dept for approval.** **Operating procedures to be issued by contractor and validated by project.** **Work permits to be used when works are carried near live installations. (distances to be defined by TA)** **Specific HAZID to be carried out with TA operations (Mc Dermott).**	**2**
13	TOP SIDES	ONSHORE PIPELINES ARRIVAL	PROXIMITY TO TRANSPORT CORRIDOR	Crossing of onshore pipes	Potential pipes damages or rupture and gas release.	Survey and marking of existing pipes carried out.	**On site checking of pipes markings.** **Insure safe clearance between existing and new pipes.** **Shut down and depressurization of existing pipes while drilling new pipe tunnel.** **Specific HAZID to be carried out with TA operations (Mc Dermott).**	**2**
14	TOP SIDES	ONSHORE PIPELINES ARRIVAL	PROXIMITY TO HOTEL FACILITIES	Crossing of onshore pipes	Potential pipes damages or rupture and gas release close to hotel facilities.	Safe distance required between new pipes and hotel as per onshore pre-project.	**Landfall and pipes route to be agreed by TA as per safety concept requirement with offshore and onshore project teams.** **Specific HAZID to be carried out with TA along with the onshore project during basic phase prior to EPC award.**	**1**

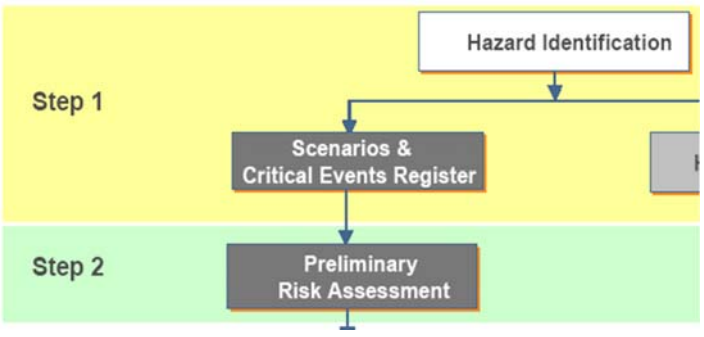
HAZAN and PRA

I. HAZard ANalysis

- **Consists in consequence study/modelling in order to obtain:**
  - Safety distances as a results of:
    - Accidental events (credible and major releases)
    - Continuous/emergency operations (e.g. flare, combustion effluents dispersion)
  - Safety distances obtained on deterministic hole sizes and effect thresholds values.

II. Preliminary Risk Assessment (PRA)

- **This semi-quantitative analysis is specific to the scenarii based method and it aims to select a limited number of major scenarii for detailed risk quantification:**

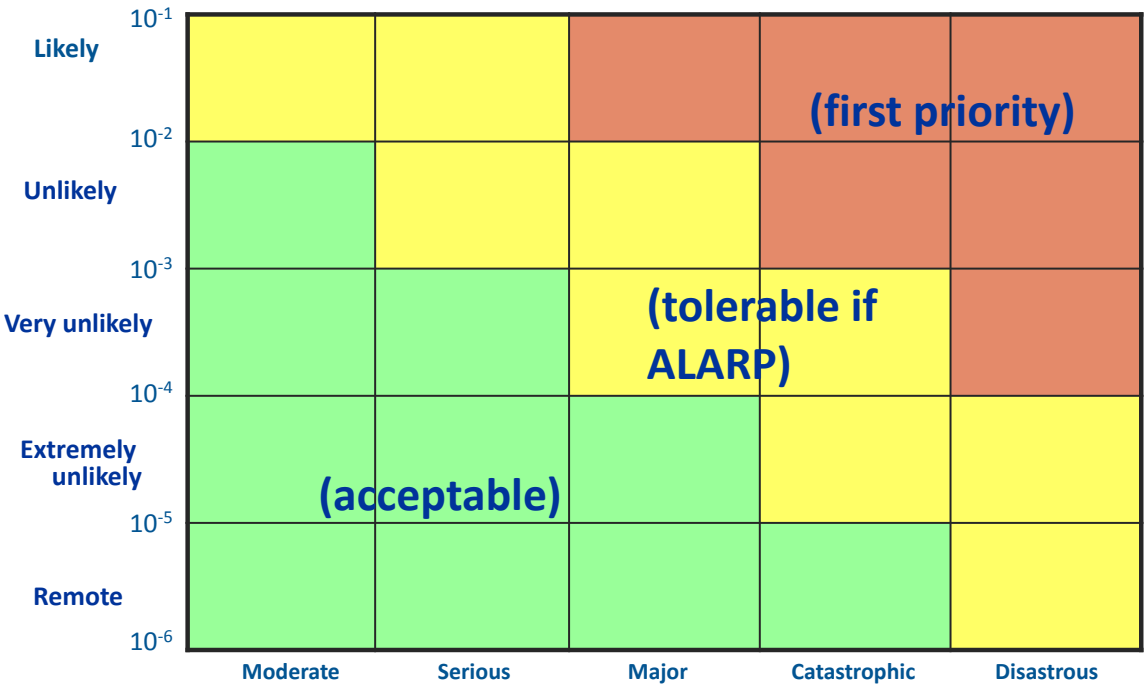


RISK assessment

- **BY Frequency (Probability) of occurrence versus time, such as:**
  - 1 per year, 1 per 1 000 years, 1 per 10 000 years, 1 per 100 000 years,1 per 1 million years, 1 per 10 million years
- **By type, nature, such as:**
  - Risk of death for 5 hours spent to go mountaineering each week-end
  - Risk of death in the industrial activities at high risks (mines)
  - Risk of death by road accident
  - Risk of death in an accident at work in an industrial activity at low risk
  - Risk of death in a fire or an explosion due to a gas leak at home
  - Risk of death by lightning
- **Assessment:**
  - By matrix ranking, for a PRA,
  - By QRA, quantitative evaluation, based on statistic record

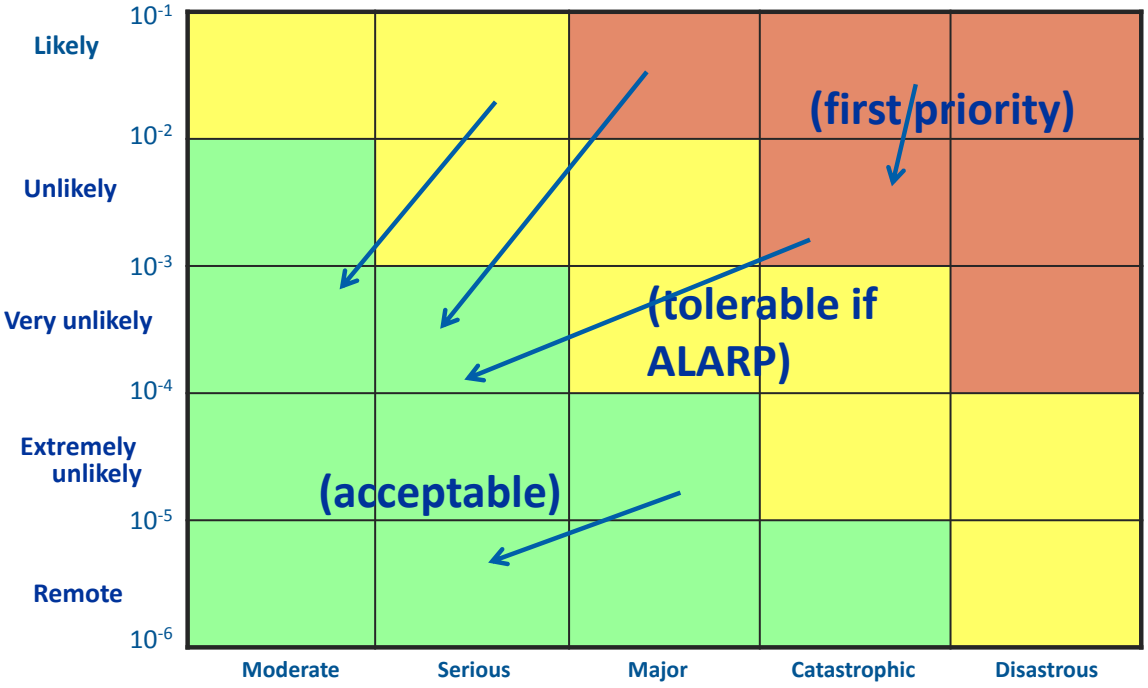
RISK – Ranking matrix

Likelihood of occurrence of the scenarios (frequency)



RISK – Ranking matrix

Impact of risk reduction measures



HAZOP (HAZARD and OPERABILITY)

Objectives:

- Identify reaction of plant during abnormal process conditions (Malfunction or mis-operation) that could cause a hazard
- Check if design adequate to prevent hazard occurring
- Check safety interfaces with other installations, surroundings
- Record all corrective actions, remedies, or remaining hazard (at an accepted level)

HAZOP review

GUIDE WORDS	MEANING	TYPICAL DEVIATIONS
NO or NOT or NONE	Negation of Intention	No flow. Operation not performed. Operator error. Operation stopped. No reaction
MORE or HIGH or HIGHER	Quantitative Increase	Flow greater than design. Temperature high. Pressure high. Too much mass of particular material. Increased mechanical stress. High static charge. High reaction rate. More reaction time.
LESS or LOW or LOWER	Quantitative decrease	Low flow. Low temperature. Low pressure (possibly negative pressure). Low mass. Low reaction rate. Loss reaction time.
PART OF	A Quantitative decrease with only part of the designer's intentions being realized.	Transfer to wrong address. Failure to transfer all components. Failure to achieve all objectives of an operation. Misidentification reaction.

PTR (Project Technical Review)

- **Interdisciplinary independent team reviews of the main documents or studies, prepared by the project and related to Safety and Operation such as:**
  - HAZID, Consequence Analysis
  - Flare, vent radiation and dispersion
  - Safety Concept, SOR
  - Hazardous area classification
  - Fire, Gas and low temperature detection
  - Pressure Protection and Relief
  - Emergency Shutdown and Emergency Depressurization
  - Active and Passive Fire Protection
  - Lay out
  - Escape Evacuation and Rescue

Safety dossier

- **Objectives**
  - Assemble all safety related documents for a permanent reference
  - Give to the operator a clear and traceable view of safety design
  - Have a safety basis for possible large modifications/extensions

- **Content**
  - SAFETY CONCEPT (updating & revisions included) Summary included if needed
  - HAZOP # 1, 2, 3
  - PTR # 1, 2, 3, 4
  - Derogation requests and supporting documents
  - List approved safety related documents
  - Safety documents & studies

Safety Concept Report

Main Purpose

- **To state company requirements for the protection of assets & personnel protection**
- **To indicate safety requirements for implementation in plant design and engineering, operation**
- **To identify derogation to reference document (Company general specification, certification, etc.)**
- **To hand out to operations team a comprehensive document on safety design of their facilities**
- **To have a document with standard content that can be audited and easily updated by basic and detailed engineering**

Safety Concept Report

Typical content

- **Bases: site conditions, meteo-oceano, surroundings, applicable references**
- **Risks, identification and prevention principles**
- **Systemised list**
  - Lay-out
  - Hazardous areas
  - Buildings-Ventilation-Pressurization
  - Blast protection
  - Electrical power (UPS, Lighting…)
  - Fire & Gas
  - ESD
  - Blow down & relief
  - Drainage
  - Active fire fighting
  - Passive fire fighting
  - Personal protection
  - Actions to be performed later by basic, detailed, operators

FOR EACH ITEM
- **Safety system goal**
- **Company decision**
- **Safety system performance**
- **Applicable document (Spec, Derogation,…)**
- **Basic engineering development**
- **Detailed engineering development**
- **Operator modification**

Safety Concept Report

- **Detailed safety studies performed:**
  - HAZID Study update,
  - P&ID Reviews,
  - HAZOP Study,
  - Consequence Analysis,
  - Project Technical Reviews,
  - Specific Safety Studies, i.e. Fire and Explosion Risk Analysis, Evacuation, Escape and Rescue Analysis, Vessel Collision Assessments…

HSE management

- About Health, Safety and Environment
- Planning HSE design activities
- Conducting HSE studies
- **Planning operational HSE activities**
- HSE reporting
- HSE performance improvement

Typical high risk situations

- Traffic
- Downgraded situations
- Change in procedures
- Inadequate or damaged tooling
- Lifting
- Work on powered systems
- Confined spaces
- Work at height
- Simultaneous operations



















Safety related to Construction phase

- **Construction challenges:**
  - Risk of specific accidental event (to personnel, equipment, etc..), with
    - Experienced Contractors selection, and yards start up,
    - Qualification of Personnel hired by contractors
    - Effective Company and Contractors effective integration, development of the project HSE culture…
- **Identification of particular risks linked to Construction**
  - Definition of Construction activities,
  - Identification of potential SIMOPS,
  - Development of Safety Management System,
  - Development of Project HSE Plan,
  - Definition of Project HSE targets for HSE Performance,
  - Selection of Contractors, review of their safety policy and goals,
  - Provision of HSE Resources – personnel, budgets, equipment, training requirements.

HSE main challenges

- **Construction challenges (Cont):**
  - Bringing together of hundreds/thousands of workers largely unknown to each other,
  - In a new yard/location with numerous unique hazards,
  - Communication of HSE requirements,
  - Training of large numbers of personnel in a short period,
  - Ensuing safe systems of work, based on good practices,
  - Supervision of construction activities,
  - Ensuring risk identification tools are properly and continuously used,
  - Using HSE targets as incentives for safe activities of the project may be discussed.

Traffic accidents







Inadequate or damaged tooling









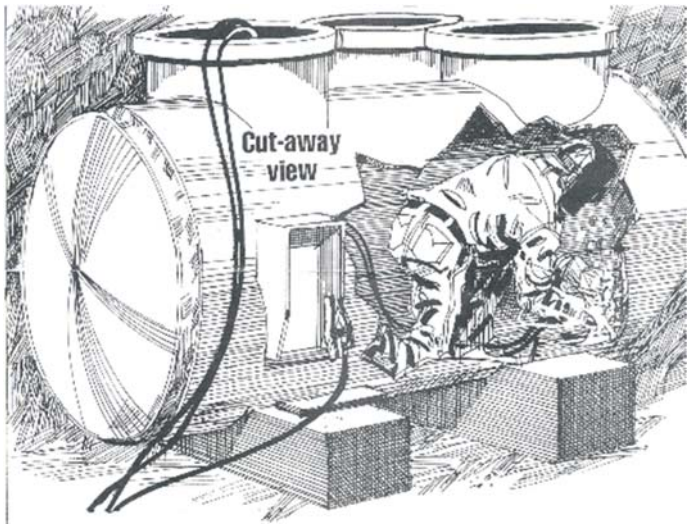
Lifting operations





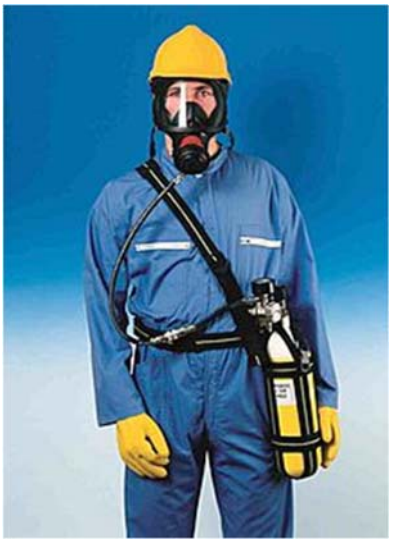


Work in confined spaces









Working at height



What would YOU do if you saw these ?.





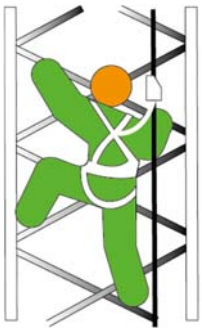


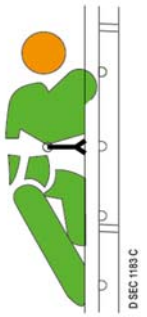




If you do see something unsafe, point it out in a constructive manner.

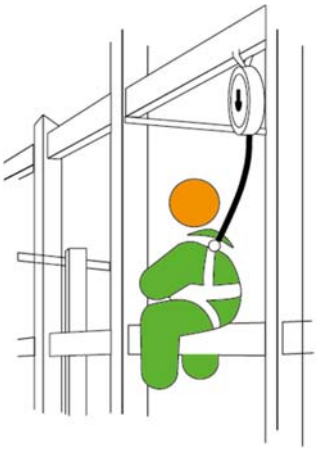
Working at height

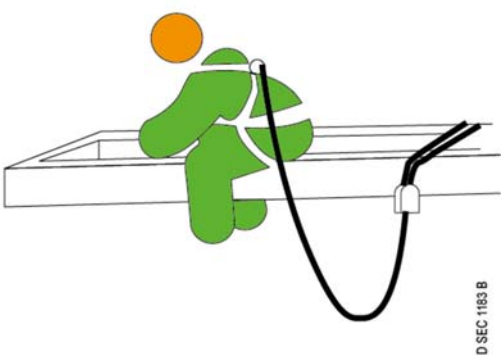


















Key aspects in HSE management

Procedures preparation & review	• HAZID/procedure review • Possible external influencing factors (SIMOPS)
Selection of personnel	• Competency assessment • Training of personnel
Pre-job meeting	• Tool box talk • Change management
Job authorization	• Permit to work (if applicable) • SIMOPS
Job supervision	• Level of supervision • Compensatory measures
Feedback and HSE reporting	• Incident reporting

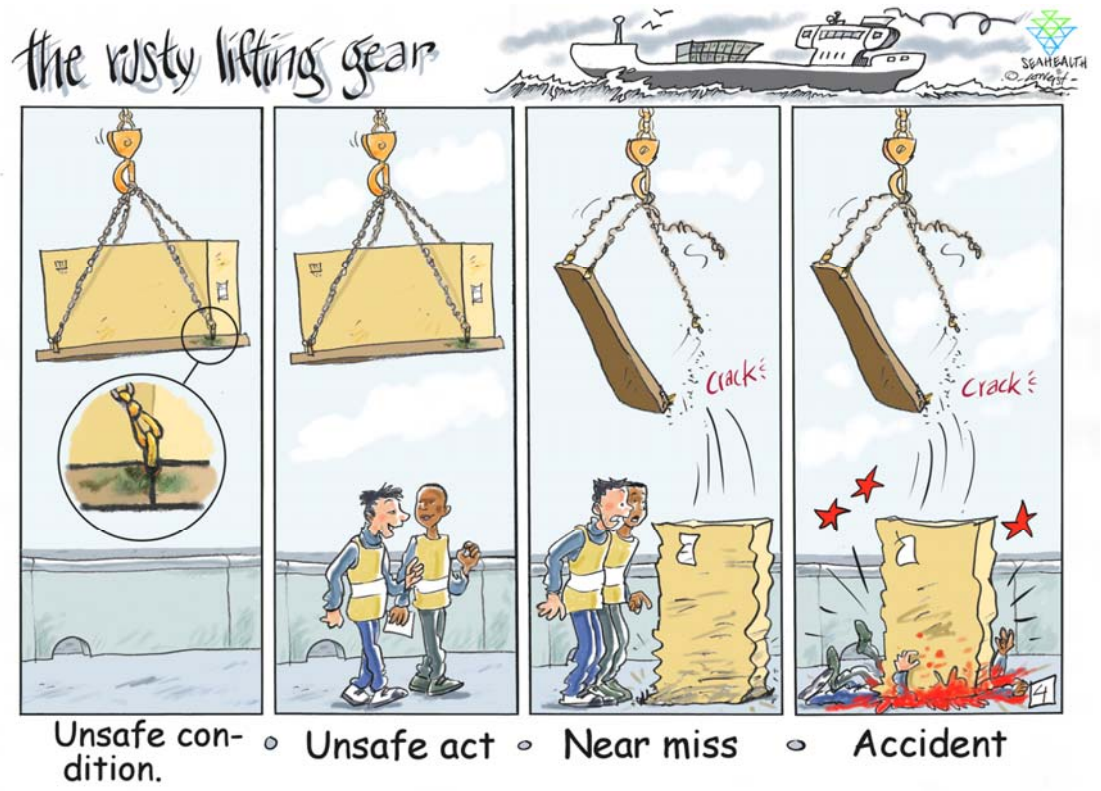
HSE management

- About Health, Safety and Environment
- Planning HSE design activities
- Conducting HSE studies
- Planning operational HSE activities
- **HSE reporting**
- HSE performance improvement

HSE reporting in projects

- **Reporting covers all activities called for by HSE policy and procedure, in detection, classification, notification, record and follow-up of incident and accident, with the final aim to reduce them, and develop AWARENESS**
- **Reporting is necessary to inform project participants about the safety performance (company, authorities, contractors…) but also needed in order to:**
  - To identify, and record, particular problems (recurring incident or accident types)
  - Take correct decisions with regards to remedial actions, implement them
  - To be used as feedback examples and learning tools for the workforce & management, as well as in Company statistics and record
  - Compare the specific performance (with others or contractual obligations etc.)
  - As a KPI (Key Performance Indicator), with given target, and monitoring

HSE in project reporting – Definitions (1)



Example of incident: the load falls into the water

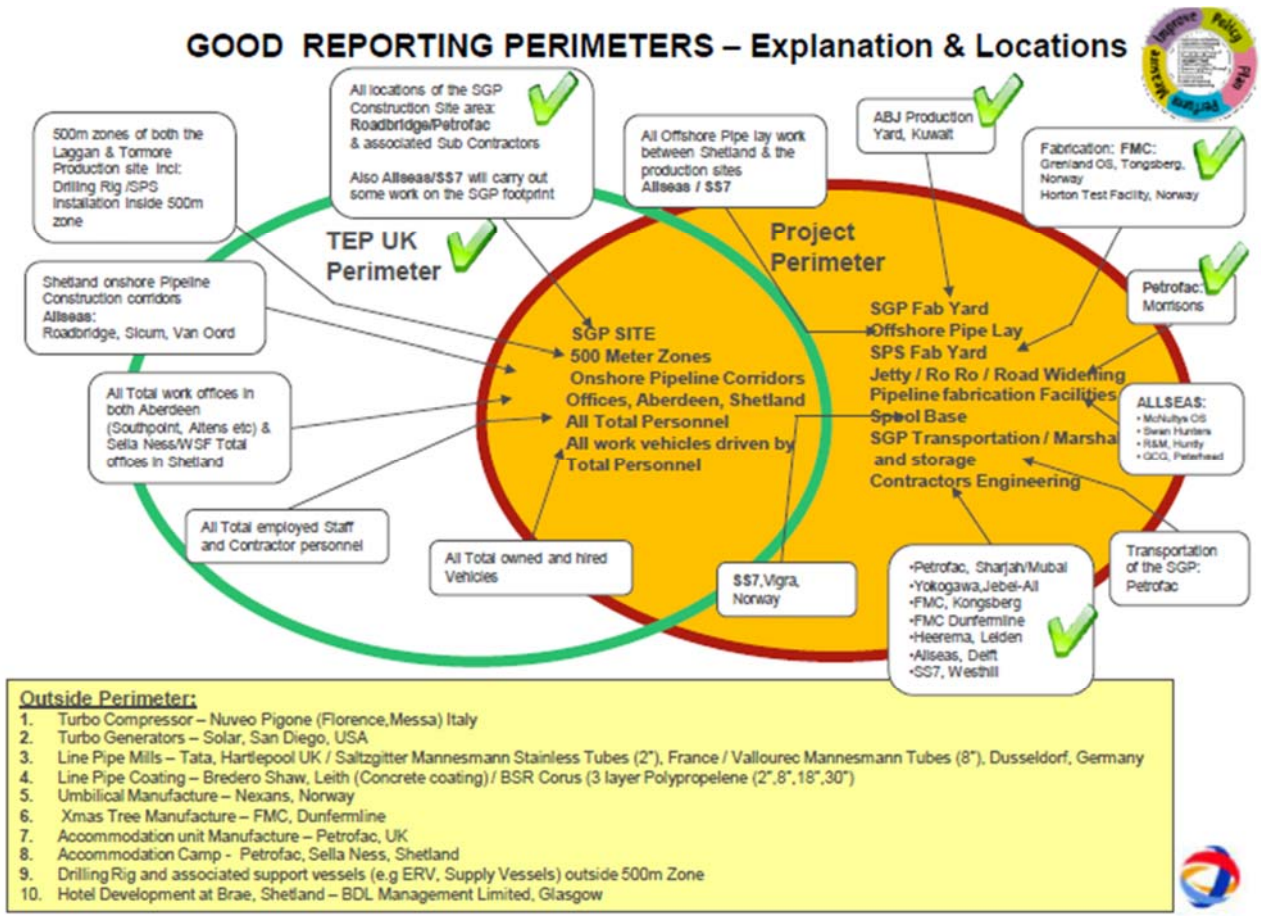
HSE in project reporting – Definitions (2)

Events			Consequences			
			Type		Field	
Incidents	Accidents		Injury	First Aid Case (FAC)	Human	
				Medical Treatment Case (MTC)		
				Restricted Work Day Case (RWDC)		
		Lost Time Accident (LTA)		Lost Time Injury (LTI)		
		Fatal Accident	Fatality			Media
	Environmental damage incident (ED)*		Damage to environment		Environment	
	Material/Production Loss Incident (ML)**		Material or Production Loss		Mat/Prod	
	Near Miss Incident		Any		Any	

* if human real severity level is 1 and material/production real severity level is lower than or equal to environmental real severity level

** if human real seventy level is 1 and environmental real severity level is lower than material/production real severity level

Reporting perimeter



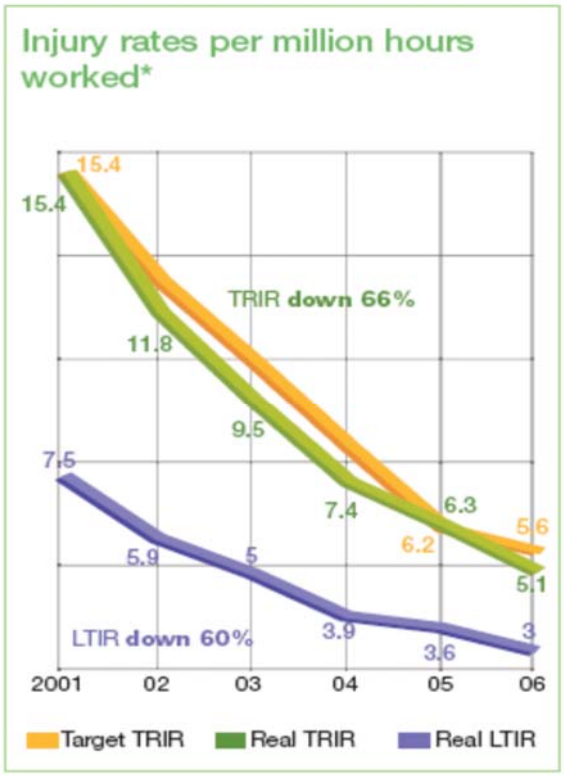
Injury rates

Total Recordable Injury Rate

- $TRIR = \frac{Fatalities+LTI+RWDC+MTC}{Worked\ manhours} \times 10^6$
- Accidents with and without lost time per million hours worked

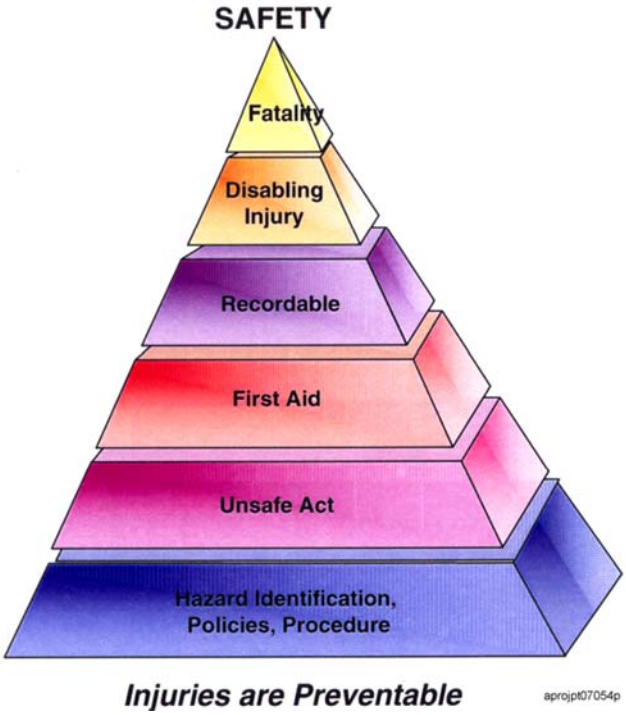
Lost Time Injury Rate

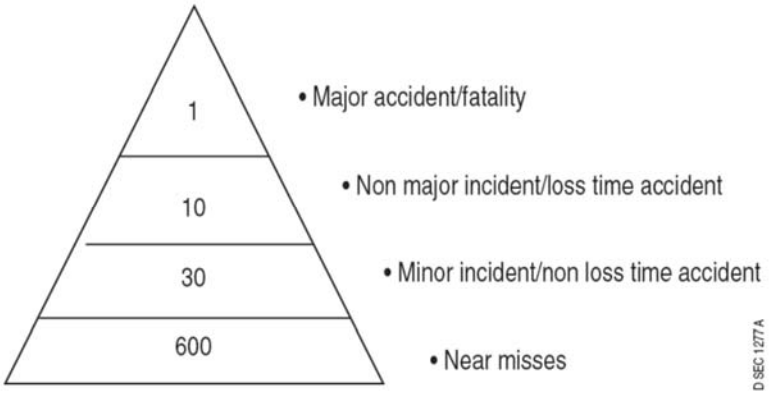
- $LRIR = \frac{Fatalities+LTI}{Worked\ manhours} \times 10^6$
- Lost time accidents per million hours worked



* Group and contractors employees.

Safety pyramids examples





HSE management

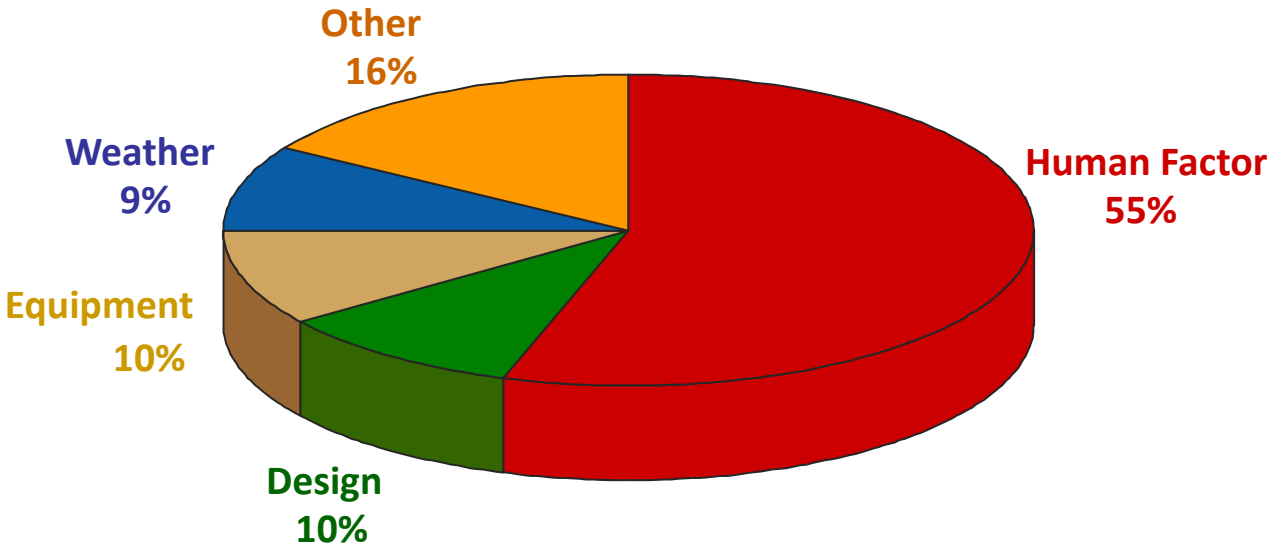
- About Health, Safety and Environment
- Planning HSE design activities
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- Planning operational HSE activities
- HSE reporting
- **HSE performance improvement**

Major factors in incidents

HUMAN FACTOR:

A major factor in incidents

Examples of incident causes in the upstream field



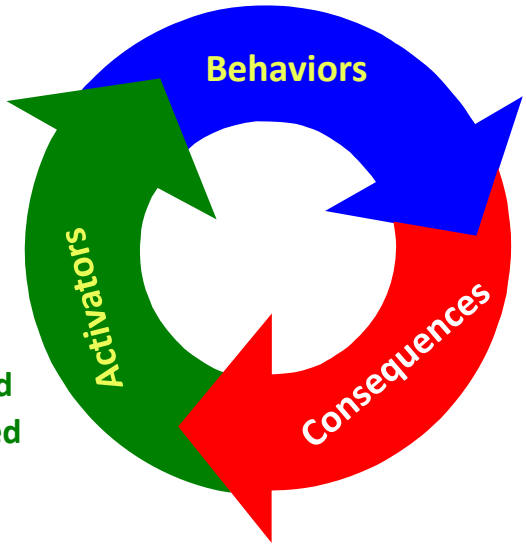
A B C for safe or unsafe behaviour

Identifies acts, conditions or systems that could cause incidents:

- **Predictive**
- **Preventive**

EXAMPLES

- **# Hazard IDs addressed**
- **# Near miss reports shared**
- **# Safety meetings attended**
- **# Safety audits completed**
- **% at risk behaviors**



Reports on result or consequence of loss/accident:

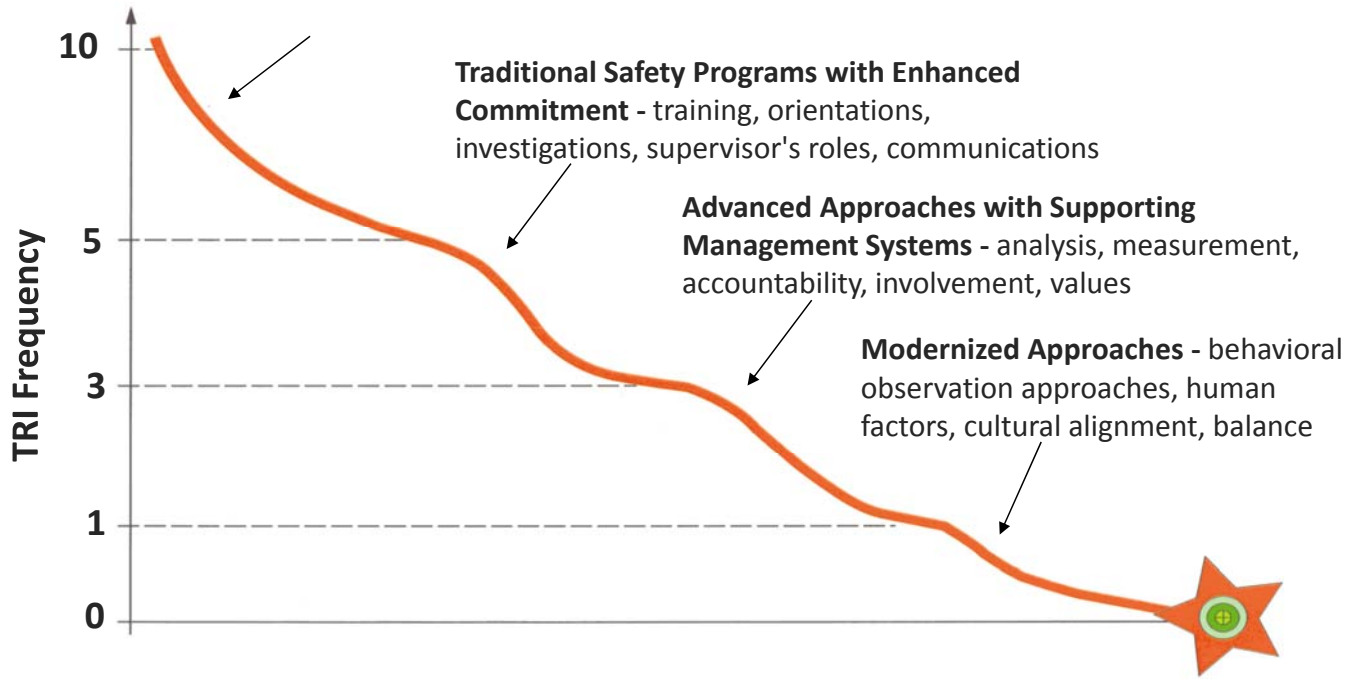
- **Reactive**
- **Corrective**

EXAMPLES

- **# LTIs**
- **# Medical treatments**
- **Spill reports**
- **Loss/Damage reports**
- **Injury frequency**

Actions taken on the proactive indicators can be used to change behaviors.

Reducing the frequency of incidents



Attitudes linked to human factors

Examples of risky behaviors and situations

- **Hard**
  - No respect of driving code, conditions,
  - Driving using mobile phone,
  - Use of broken tools,
  - Ignorance of conditions (weather, sea state, soft ground, etc.)
- **Soft**
  - Lack of attention, concentration
  - Expect, request help from non qualified person,
  - Ignore work preparation, for oneself, as group , in particular safety briefing
  - Assume everyone understand the situation,
  - Neglect adverse physical condition of participant(s) (tiredness, sickness, strength)

Summary



- **The safety of future operations starts with a safe design**
- **A safety concept report must be produced to detail all safety precautions or measures built into the design**
- **Risks and consequences should be assessed thoroughly and unacceptable risks should be either eliminated or mitigated to an acceptable level in accordance with the ALARP principle**
- **The impact of the project on the environment should be assessed and an initial baseline established**
- **The risk to personnel is highest during the construction/installation phase. An action plan should be established to monitor those activities and HSE personnel assigned in sufficient numbers**
- **The project safety performance is a key factor to be constantly monitored by top management. HSE performances have been considerably improved thanks to persistent efforts, but vigilance will always be necessary to maintain and improve them**



Quality

Quality management

Foreword

- **Main objective**
  - Contractor and Company might not have the same objectives
  - Yet Company needs to be satisfied by its contractors and vendors

- **Main tools and means**
  - Process
  - Performance indicators
  - Audits

Quality management

About quality

- Quality Management principles
- Project Quality management

Planning quality management

Performing Quality Assurance

Performing Quality Control

Quality Management Principles

- **Quality Management has four main components:**
  - Quality planning
  - Quality assurance
  - Quality control
  - Quality improvement
- **For Company during contract phase**
  - Quality Surveillance replaces Quality Control in order to supervise Contractor
- **Quality Management does not only aim to ensure 'good quality' of a product but rather to ensure that an organization or product is consistent.**
- **Quality Management is focused not only on product/service quality but also on the means to achieve it.**
- **Quality Management uses quality assurance and control of processes as well as products to achieve more consistent quality.**

Definitions

Quality Assurance

Quality Assurance is the management process of systematic planning, implementing and evidencing organizational provisions, which, if properly applied, will reasonably assure CUSTOMER that the quality of the final product will be achieved in line with the Contract requirements

Quality Control

Quality Control is the CONTRACTOR operational process of inspecting and testing individual components or assembled units or packages to check the conformity to Contract requirements, complemented by the recording of associated data

Quality Surveillance

Quality Surveillance is the COMPANY process of monitoring at second level that the Quality Assurance and Quality Control are properly implemented by CONTRACTOR

Company management system

Definition

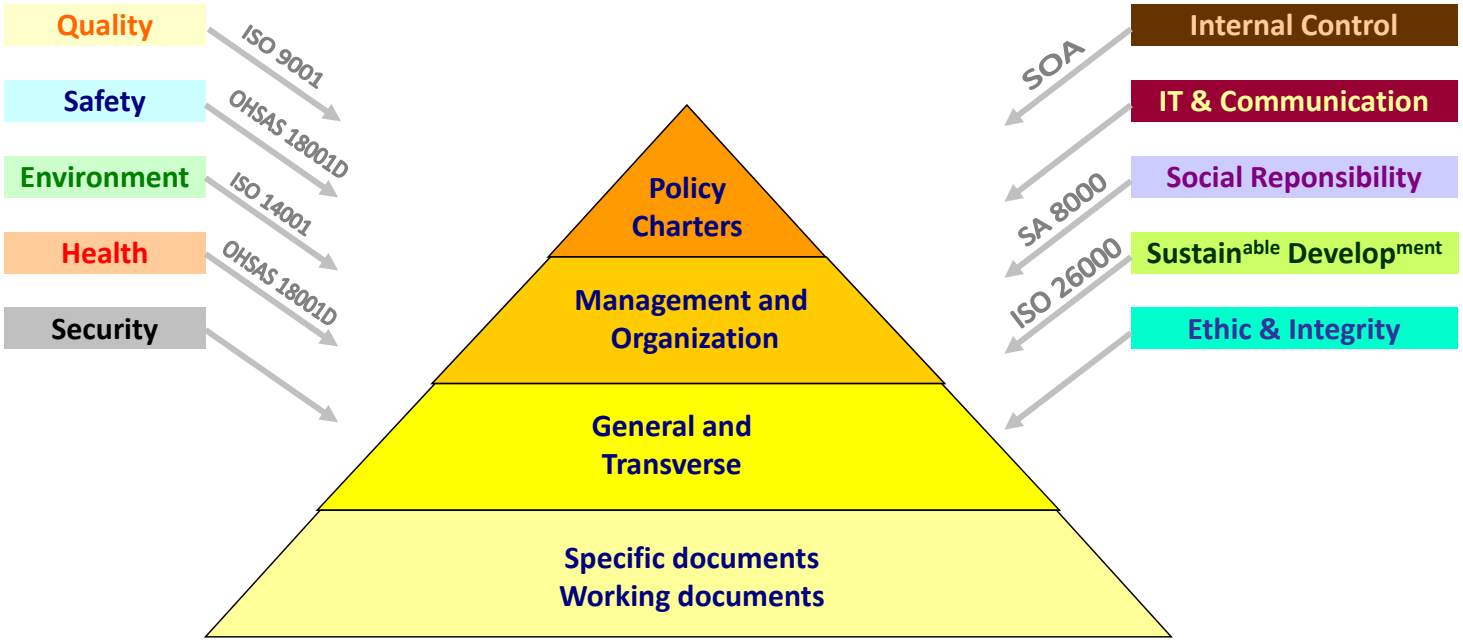
- Global management system (organization, responsibilities, processes and resources) to steer and control the company activities in an efficient and responsible manner described in a structured documentation.

Notes

- Application is mandatory to all Organic personnel
- “Efficient and responsible” encompasses the compliance with the applicable Rules and Regulations and Corporate Referential
- The CMS contains the HSE MS and any type of organized system contributing to the main objective (including Internal Control)
- Benefits of operating such a system:
  - Sharing corporate value
  - Policies and business objectives
  - Clarifying the organization
  - Setting common rules for the day-to-day activities

Quality Management Principles

Thematic views across CMS documents



NOTES: OHSAS 18001:2007: Occupational Health and Safety Assessment Series
SA 8000: "Social Accountability 8000" standard
SOA: Sarbanes-Oxley Act of 2002 (*financial report deficiencies identification).*
ISO 26000: Guidance on social responsibility *(previously: SD 21000)*

Key Quality standards

INTERNATIONAL STANDARD **ISO 9000** — 2015

Quality management systems — Fundamentals and vocabulary

INTERNATIONAL STANDARD **ISO 9001** — 2015

Quality management systems — Requirements

INTERNATIONAL STANDARD **ISO 9004** — 2009

Quality management systems — Guidelines for performance improvements

INTERNATIONAL STANDARD **ISO 10006** — 2003

Quality management systems — Guidelines for quality management in projects

TECHNICAL SPECIFICATION **ISO/TS 29001** — 2010 — Dedicated Oil & Gas

Petroleum, petrochemical and natural gas industries — Sector-specific quality management systems — Requirements for product and service supply organizations

Design a simple ISO 9001 compatible System,
helping implement locally the Project Policy/commitments/objectives

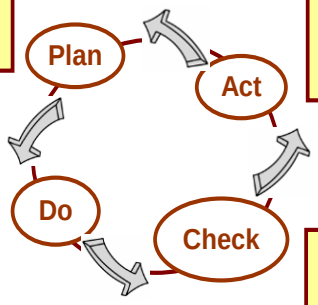
Key Quality standards

ISO 9001	Quality Management Standard
ISO 14001	Environmental Management Standard
OHSAS 18001	Occupational Health and Safety Management Standard
ISO 17025	Laboratory Management Standard
HACCP-9000	encompasses all of ISO 9001 plus food and beverage (inc. water) specific requirements.
ISO/TS 16949	encompasses all of ISO 9001 plus Automotive specific requirements. Replaces QS 9000.
ISO 13485/13488	encompasses all of ISO 9001 plus Medical Device specific requirements.
AS 9100	encompasses all of ISO 9001 plus Aerospace specific requirements.
TL 9000	encompasses all of ISO 9001 plus Telecommunication specific requirements
ISO 9000	Fundamentals and Vocabulary for using ISO 9001 and ISO 9004
ISO 9004	Guidelines on implementing ISO 9001 and continuous improvement
ISO 10005	Guidelines for Quality Plans
ISO 19011	Guidelines for Auditing
ISO 10012	Guidelines for Calibration
Malcolm Baldrige	Business Excellence Standard

Quality Management Principles

The Basic principle of the Quality Management: The PDCA cycle ➔ the improvement loop

PLAN :
- Policy
- Objectives
- Action plans



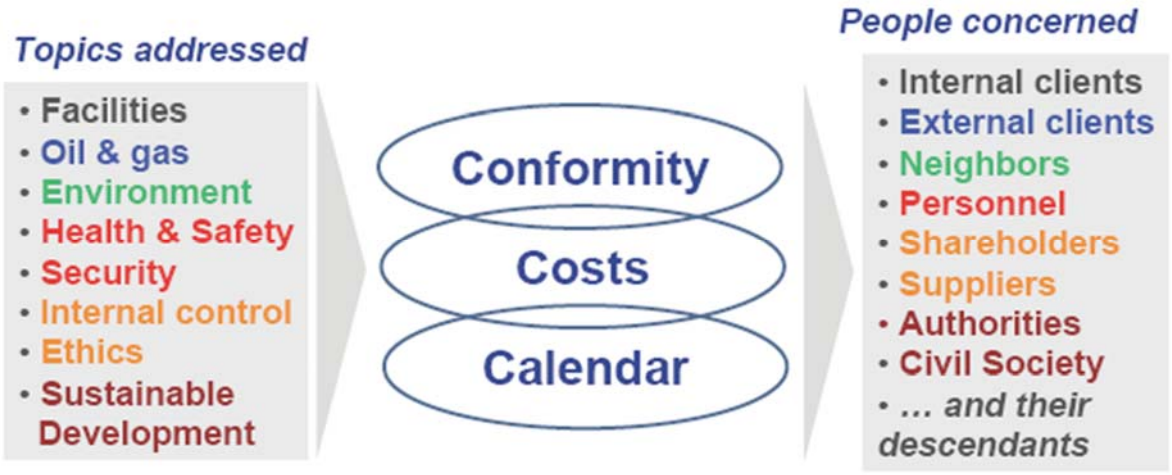
ACT :
- Management reviews
- Improvement directions

DO :
- Run Corporate operational and support processes
- Implement action plans

CHECK :
- Reviews / Audits
- Performance indicators
- Dashboard

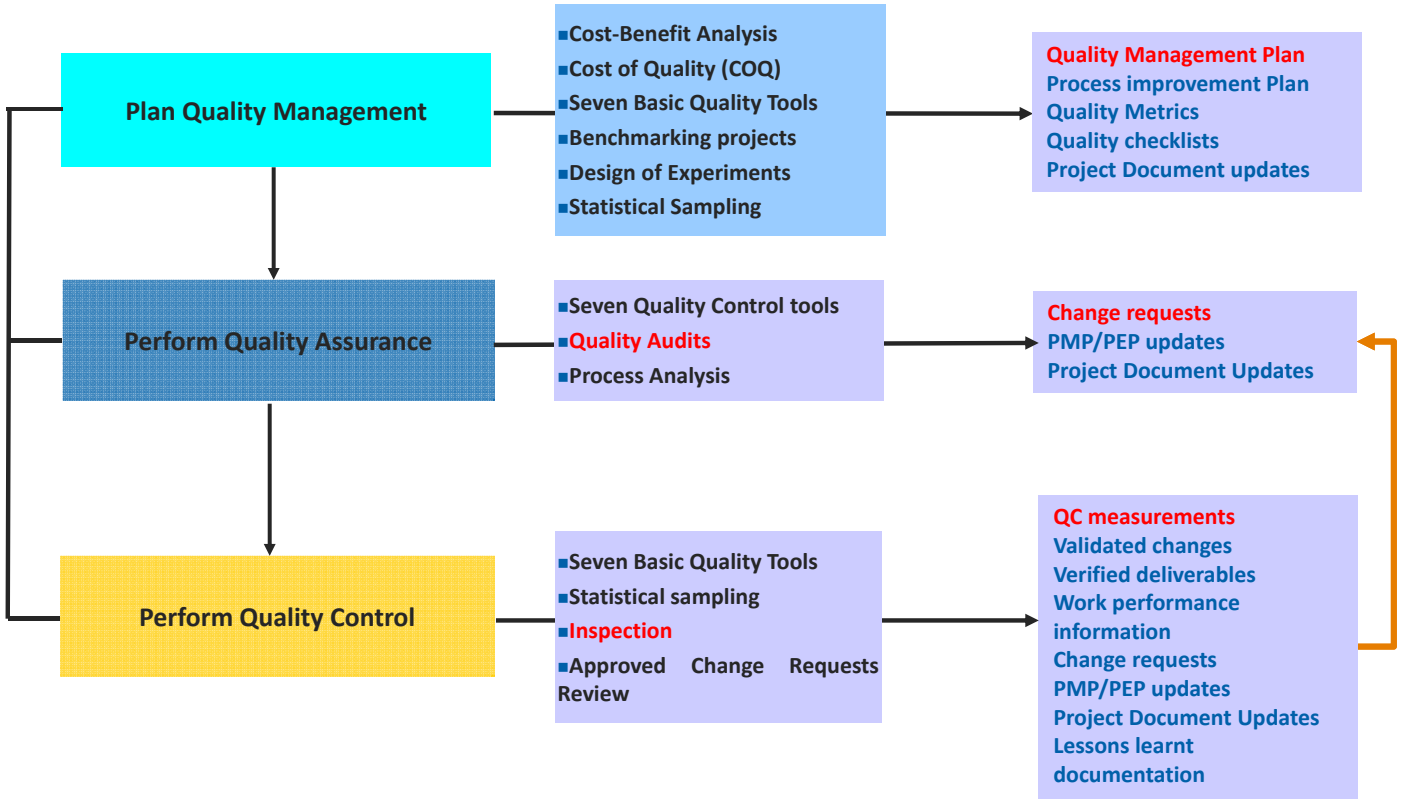
Project Quality Management

- **Quality is the sustainable satisfaction of clients by respecting**
  - technical conformity
  - budget
  - delivery date



Above all Quality means: SATISFACTION

Project Quality Management Processes



- ***Quality Assurance focuses on non-quality prevention and process improvement***
- ***Quality Assurance is affected by the results of Quality control***

Quiz 1

- **Quality is**
  - A. Meeting and exceeding the customer's expectations
  - B. Adding extras to make the customer happy
  - C. The degree to which the project meets requirements
  - D. Conformance to management's objectives

Quality management

- About quality
- **Planning quality management**
- Performing Quality Assurance
- Performing Quality Control

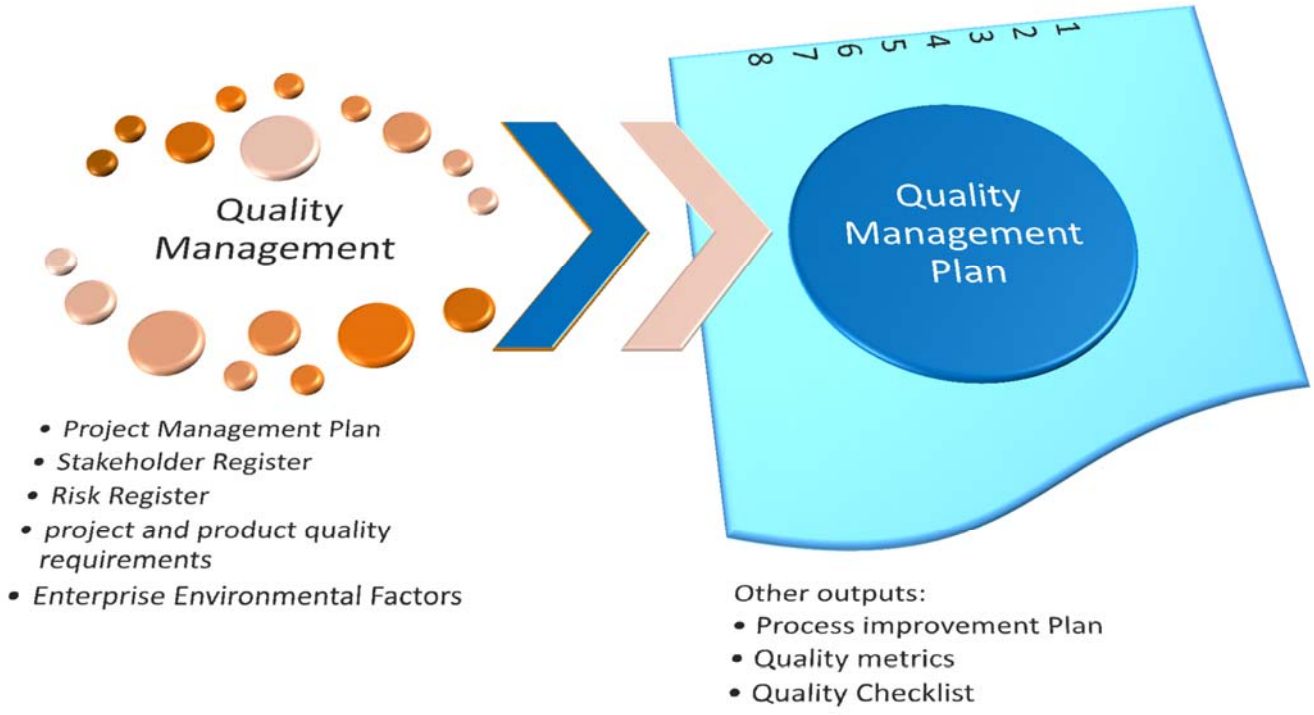
Quality Management process

Main objective

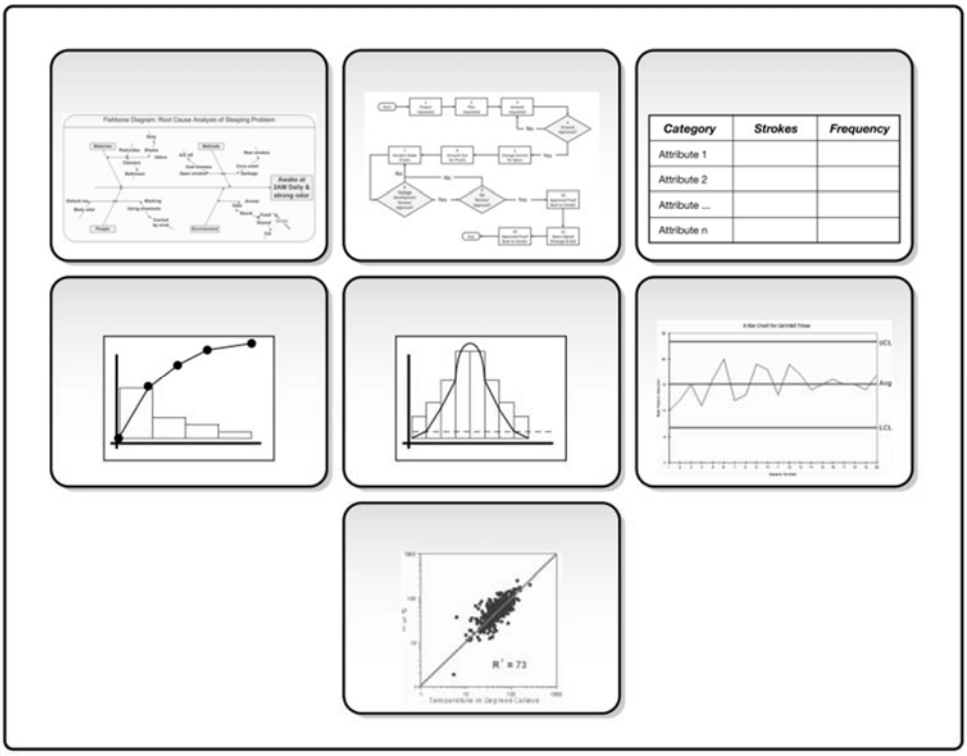
- **To provide guidance and direction on how quality will be managed and validated throughout the project by**
  - Identifying quality requirements and/or standards for the project and its deliverables
  - Documenting how the project will demonstrate compliance with relevant quality requirements and/or standards.

Quality Management process

Input



Seven basic quality tools



- *Cause-and-effect diagrams*
- *Flowchart*
- *Checksheets*
- *Pareto diagrams*
- *Histograms*
- *Control Charts*
- *Scattered diagrams*

Example of content of a Project Quality Plan

1. Definitions and abreviations
2. References and applicable documents
3. Project Quality Management System
4. Management responsibility
5. Resource management
6. Project Execution
7. Control
8. Continous Improvement

PLAN

DO

CHECK

ACT

Project Objectives from a quality point of view

Measurable objectives

- Avoid "mission statements"
  → *Quality charter*
- It is important to know where CPY/CTR stands with respect to objectives
  → *Continual management of dashboard/indicators*
- For a global Project view specific indicators per activity type should be defined
  → *HSE/Quality/Risk/Project Management…*

Objectives defined right at the beginning in order to

- Empower project team
- Allow a coherent project organization
- Enhance team spirit during the Project

Objectives should be both realistic and challenging

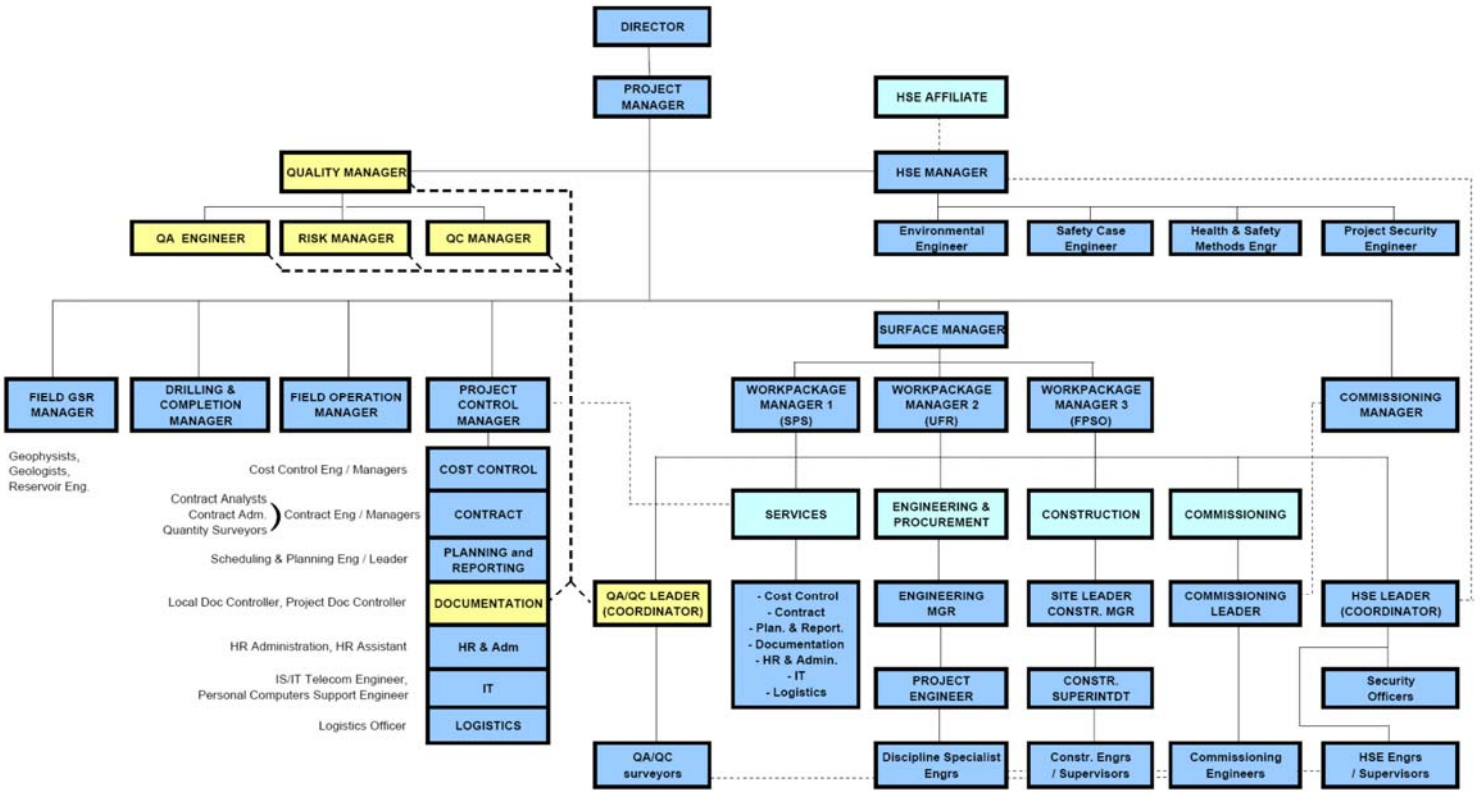
Typical Project objectives

A strong Safety Management Philosophy and Procedures	***QMS/Procedures***
Skilled and motivated Project Team	***Visits, selection, recruitment, indicator turnover***
Excellent communication within the Project Team	***Communication activities***
Well known and user friendly Quality Management System	***QA Induction***
Continuous improvement	***Audit, Management Review***
Strong interface management	***Dedicated team member in interface***
Effective Management of Risks and Opportunities	***Dedicated team member in Risk***
Effective Management of Change	***CPN, SCN, REX Filter/Register***
Efficient Documentation surveillance	***DCC, QC***
Document Management and Control	***Dedicated team member in DCC***
Quality Surveillance and Inspection	***PSP/PIM***
Effective Field Operations preparation	***Anticipation of activity+ participation to the project***

Defining the relevant indicators → Insurance of accurate objectives

Project Quality Organization

Necessity of quality independence

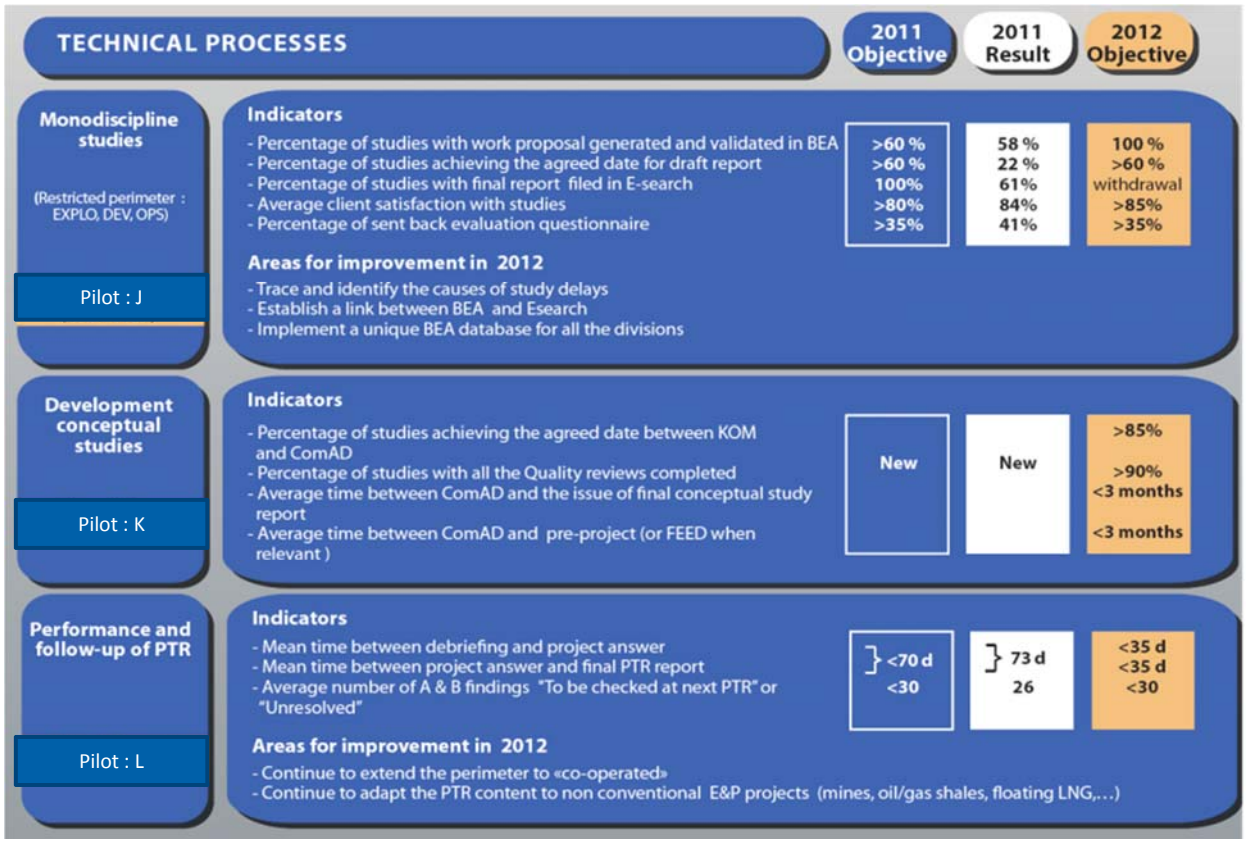


As for HSE, each Project team member works towards quality achievements

Examples quality indicators for business processes

BUSINESS PROCESSES	2011 Objective	2011 Result	2012 Objective
Evaluation and monitoring of international Suppliers — Pilot : A			
Indicators			
- Percentage of qualification requests exceeding 6 months	<20 %	31 %	<20 %
- Percentage of suppliers with a consolidated evaluation of their performance (based on 32 strategic suppliers)	100 % (based on 50 suppliers)	51 % (based on 50 suppliers	100 %
Areas for improvement in 2012			
- Process steering reinforcement			
- Implementation of the ISDB suppliers database and associated deployment (information, training)			
- Supplier panel structuring and implementation of an adapted management model			
- Issue of the application guide for CR EP CA 530			
Management of technical feedback — Pilot : B			
Indicators			
- Average number of Rex issued each month (raw and reaction)	>30	24	50
- Average time for raw REX validation	<10 d	10 d	5 d
- Average time taken for a Synthesis Rex issue	<180 d	134 d	<150 d
- Number of REX each year factored into the Technical Referential updates	> 20	6	Withdrawal
- Number of consultation per day	New	New	Calibration
- Number of subscriptions	New	New	Calibration
Areas for improvement in 2012			
- Implementation of the communication plan			
- Potential extension of the process perimeter to other Rex tools			

Examples quality indicators for technical processes



TECHNICAL PROCESSES		2011 Objective	2011 Result	2012 Objective
Monodiscipline studies (Restricted perimeter : EXPLO, DEV, OPS) — Pilot : J	Indicators			
	- Percentage of studies with work proposal generated and validated in BEA	>60 %	58 %	100 %
	- Percentage of studies achieving the agreed date for draft report	>60 %	22 %	>60 %
	- Percentage of studies with final report filed in E-search	100%	61%	withdrawal
	- Average client satisfaction with studies	>80%	84%	>85%
	- Percentage of sent back evaluation questionnaire	>35%	41%	>35%
	Areas for improvement in 2012			
	- Trace and identify the causes of study delays			
	- Establish a link between BEA and Esearch			
	- Implement a unique BEA database for all the divisions			
Development conceptual studies — Pilot : K	Indicators			
	- Percentage of studies achieving the agreed date between KOM and ComAD	New	New	>85%
	- Percentage of studies with all the Quality reviews completed			>90%
	- Average time between ComAD and the issue of final conceptual study report			<3 months
	- Average time between ComAD and pre-project (or FEED when relevant)			<3 months
Performance and follow-up of PTR — Pilot : L	Indicators			
	- Mean time between debriefing and project answer	<70 d	73 d	<35 d
	- Mean time between project answer and final PTR report	<30	26	<35 d
	- Average number of A & B findings "To be checked at next PTR" or "Unresolved"			<30
	Areas for improvement in 2012			
	- Continue to extend the perimeter to «co-operated»			
	- Continue to adapt the PTR content to non conventional E&P projects (mines, oil/gas shales, floating LNG,...)			

Quiz 2

- **Who is ultimately responsible for quality management on the project?**
  - A. Project engineers
  - B. The project manager
  - C. The project Quality manager
  - D. All team members

Quiz 3

- **Pareto charts help the project manager**
  - A. Focus on the most critical issues to improve quality
  - B. Focus on stimulating thinking
  - C. Explore a desired future outcome
  - D. Determine if a process is out of control

Quality management

- About quality
- Planning quality management
- **Performing Quality Assurance**
- Performing Quality Control

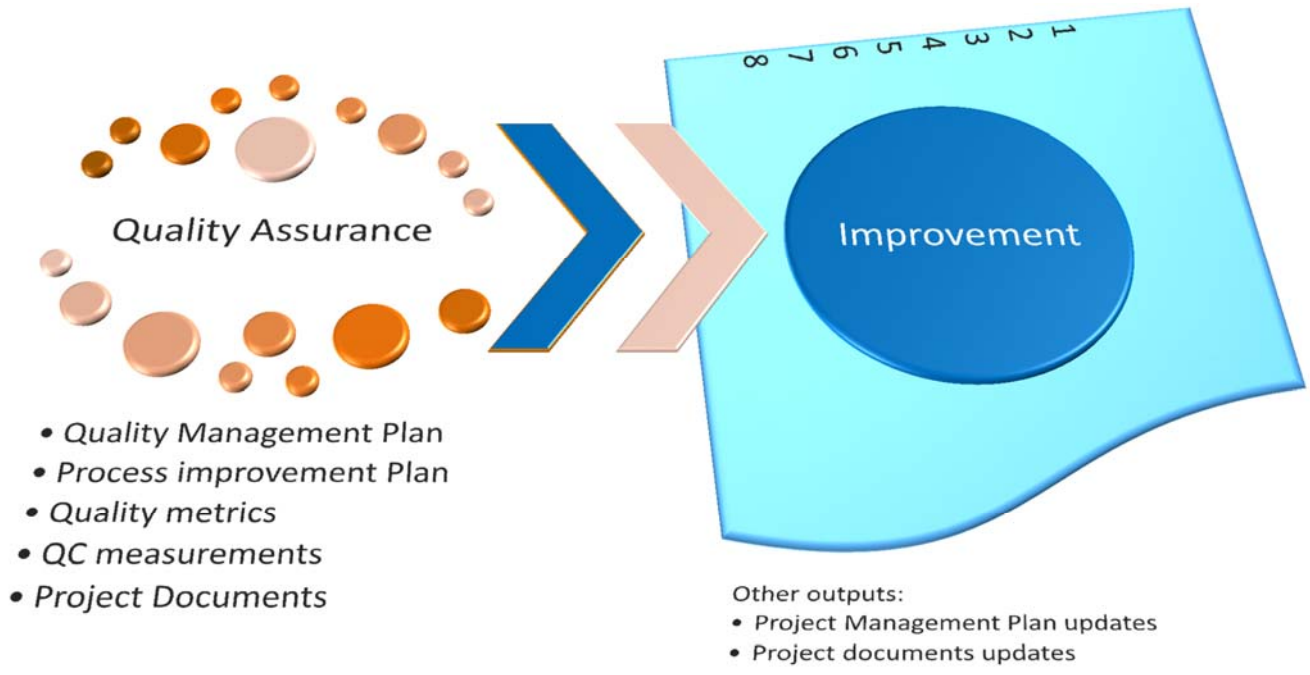
Quality Assurance process

Objectives

- **To ensure that appropriate quality standards and operational definitions are used by**
  - Auditing the quality requirements and the results from quality control measurements
  - Preventing defects through the planning processes
- **To facilitate the improvement of quality processes**

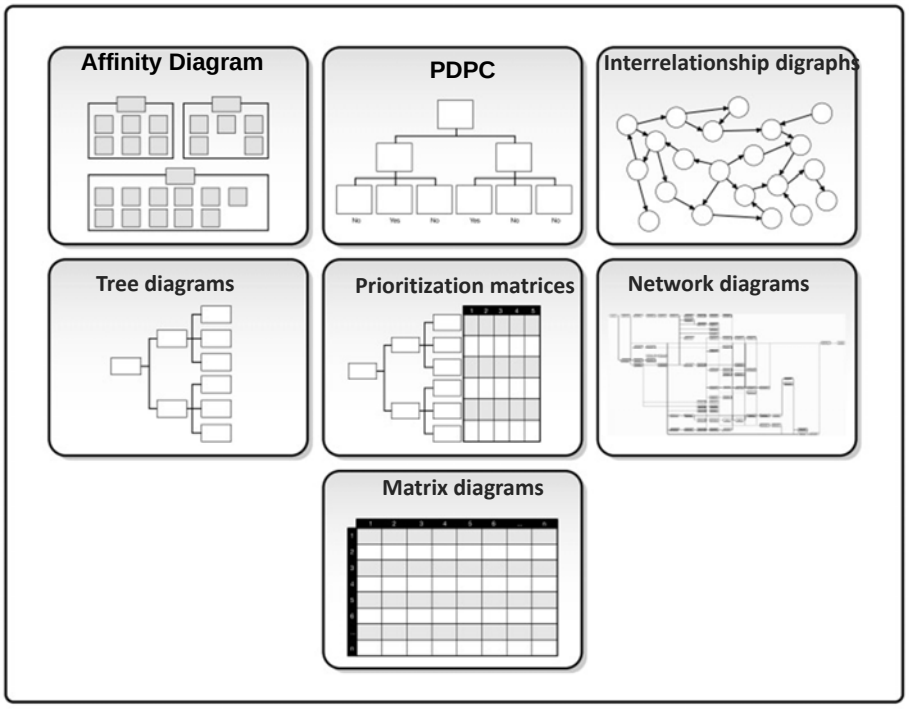
Quality Assurance process

Input



- ***Improvements in order to take corrective action, preventive action, or to perform defect repair***
- ***PMP Updates (Quality, Scope, Schedule, Cost Management Plan)***

Seven basic quality assurance tools



- ***Affinity diagrams (Mind mapping)***
- ***Process decision program charts (PDPC)***
- ***Interrelationship digraphs***
- ***Tree diagrams (WBS, OBS, PBS)***
- ***Prioritization matrices***
- ***Activity network diagrams***
- ***Matrix diagrams***

Process tools to perform quality assurance

Quality Audits

- A quality audit is a structured and independent review to determine whether project activities comply with organizational and project policies, processes and procedures

Process Analysis

- Process analysis follows the steps outlined in the process improvement plan to identify needed improvements
- This analysis also examines problems experienced, constraints experienced, and non-added-value activities identified during process operation.

Quiz 4

- **All of the following result from quality audits except**
  - A. Determination of whether project activities comply with organizational policies
  - B. Improved processes to increase productivity
  - C. Creation of quality metrics
  - D. Confirmation of the implementation of approved change requests

Quality management

- About quality
- Planning quality management
- Performing Quality Assurance
- **Performing Quality Control**

Quality Control process

Objectives

- **To assess performance and recommend necessary changes by**
  - Identifying the causes of poor process or product quality
  - Recommending and/or implementing actions to eliminate them
  - Ensuring that project deliverables and work meet the requirements specified
  - Monitoring and recording results of quality activities

Project Quality Surveillance vs. Project Phase

RG: Registration (Classification)
CA: Certification by Accredited body
BC: Basic Certification
QS: Quality Surveillance by 2nd Party (COMPANY)
QC: Quality Control by 1st Party (CONTRACTOR or Supplier), exceptionally by COMPANY for well equipment

		D Design (conceptual & pre-project)	E Engineering (basic & detailed)	P Procurement & fabrication	Construction & Installation	I Commissioning	C Field operation - GS EP EXP 211	S Field Abandonment	A ("decommissioning")	Comments
Floating and marine	- hull, marine, evac. & mooring systems - cargos, marine utility systems - offloading (incl. mooring & anchoring)	QC	RG	RG	RG	RG	RG	QS		See CR EP LSO 200
Safety Equipment	- lifting appliances - safety detection & HIPPS - fi-fi & evac. Systems	QC	CA	CA	CA	CA	BC / QS	QS		BC for lifting appliances and hard HIPPS in phase S
Main Bearing Structure	- foundations & jacket primary struct. - topside primary struct. (+ flare & bridge) - permanent template structure	QC	BC	BC	BC / QS	QS	QS	QS		BC in sub-phase "C" QS in sub-phase "I"
Transportation System	- pipelines - flexible lines & umbilicals - riser systems	QC	BC	BC	BC / QS	QS	QS	QS		"I": BC for riser tower, catenary, top-tensioned riser & flex-joint
Production Critical Equipment CR EP PJC 551	- rotating machines - valves & subsea equipment (idem) - HP vessels & exchangers	QC	QS*	QS*	QS*	QS	QS	QS		
Other Structure & Topsides	- onshore & offshore - utility systems (except marine)	QC	QS	QS	QS	QS	QS	-		* : independant review or surveillance by Head Offices
Sensitive Wells CR EP FPO 211 § 3.2	- tubulars - well equipment	QC	QS *	QS(1)	QC(2)	QC(2)	QC(2)	QC(2)		
Standard Wells CR EP FPO 211 § 3.2	- tubulars - well equipment	QC	QC	QS(1)	QC(2)	QC(2)	QC(2)	QC(2)		

(1) For Wells, QS is used for designating the control performed by COMPANY over the suppliers of equipment acting as independent CONTRACTORS performing a defined scope of work.

(2) For Wells, QC is used for designating the control performed by COMPANY over its CONTRACTORS acting as service companies performing work under COMPANY responsibility and instructions.

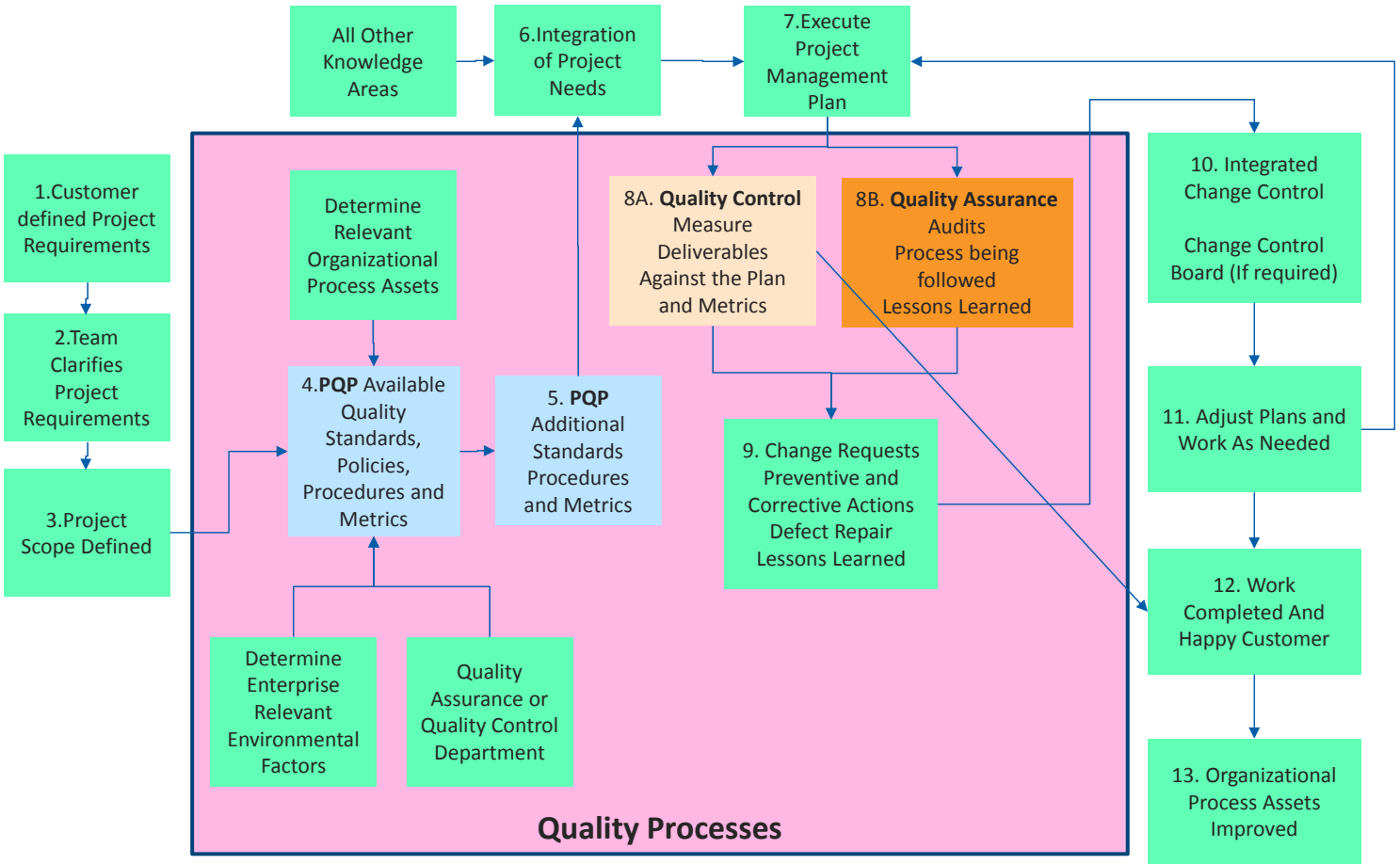
Quiz 5

- **All the following are tools to perform quality control except**
  - A. Inspection
  - B. Cost of quality
  - C. Pareto chart
  - D. Fishbone diagram

Quiz 6

- **Consider several ongoing activities on a project and imagine you are getting concerned about the accuracy of progress reporting by your team members**
- **How to verify if there is a problem?**
  - A. Quality audits
  - B. Risk quantification reports
  - C. Regression analysis
  - D. Monte Carlo analysis

Quality management in the real world



Project Quality Surveillance

Certification and Clasification

Certification

- formal procedure by which an accredited or authorized organization (person or agency) assesses, verifies and attests in writing (by issuing a certificate)
- the attributes, characteristics, quality, qualification, or status of individuals or organizations, goods or services, procedures or processes, or events or situations, in accordance with established requirements or standards
  - Marine Warranty Surveyors (MWS) are not certification bodies as such (their first objective is to protect the interests of Insurance Companies), but their advice or instructions are valuable

Classification (or Registration)

- procedure by which a certified organization records a product, process or service, in an appropriate list publicly available.
  - e.g. organization confirming the class under which a vessel is registered.

Registration providers:
- Bureau Veritas
- Det Norske Veritas
- Lloyds Register of Shipping
- American Bureau of Shipping
- Germanischer Lloyd
- Russian Bureau of Shipping

Recognized MWS:
- Noble Denton
- London Offshore Consultants
- Falconer Bryan & Associates
- Global Maritime

Project Quality Surveillance

Verifying parties

- **First party**
  - Verifications are performed by the Entity on their own output or on their behalf
    - e.g. department within the organization

    →QC department of Contractor
- **Second party**
  - Verifications are conducted by the customer or by others on their behalf

    → Company surveillance
- **Third party**
  - Verifications are conducted by external, independent organizations
    - such as those ISO 9001 or ISO 1400 certified

    → IVB: Independent Verification Body

Project Quality Surveillance

Quality Control Plan

- **The QCP is the document describing the contractor operational processes of control**
  - Review
  - Verification
  - Qualification (in case of special processes)
  - Inspection
  - Testing activities throughout all phases of the works

QC activities are 1st party responsibility

Project Quality Surveillance

Inspection & Test Plan

- **The ITP is the consolidated document issued by the Contractor**
  - listing all the manufacturing activities of a unit
    - execution works and QC activities
  - and proving the link to the evidences of their satisfactory performance
    - associated Quality Records
- **Each listed manufacturing activity shall be the purpose of checks/verifications as defined by the ITP**
- **Evidence of acceptance at completion of the related activity is essential**
  - co-signatures of the various entities involved
- **At end of execution, the ITP shall be formally approved as proof of satisfaction of all manufacturing activities performed**
  - co-signatures of the different parties

Inspection refers to a manufacturing process

Project Quality Surveillance

Surveillance Plan

- **The Surveillance Plan is a consolidated document listing**
  - all the different activities performed on a contracted work
    - Project
    - Package
    - Work Package
    - Equipment…
  - and the associated surveillance activities to be performed in order to ensure the Customer that work is satisfactory performed by Supplier
- **The Surveillance plan considers supplier's QA/QC activities and their output (records)**
- **Survey actions focus on critical items previously identified as such within risk analysis**
- **When necessary, specific/reinforced survey actions by client are defined in addition/complement to those planned by supplier**

Surveillance activities are the responsibility of second and third parties

Surveillance philosophy and strategy

- **Objectives**
  - To allow the project team members to react quickly
  - To complement QC activities planned by contractor
  - To substitute to inadequate contractor QC activities
- **Why?**
  - Because Contractors and Operators have different perspectives
  - Because Control/Surveillance cannot be improvised once activities are on their way
  - To prepare the sub contracts and their follow-up mechanisms
  - To anticipate work volume and resources to cover inspection
  - To supplement Contractor and take-over in case of its failure
- **When?**
  - During basic engineering phase
  - Once equipment lists are available

Surveillance philosophy and strategy

- **Key surveillance principles**
  - Quality audits and guidance on Quality issues
  - Quality Control assessment (at manufacturing sites)
  - Document reviews
- **Consideration with regards to Certified Contractors**
  - Any ISO-certified contractor is likely to have an advantage over the others in terms of
    - quality understanding
    - quality methodology
  - However, Quality is also an attitude and it is not granted forever
  - Feedback shows lots of deficiencies in Quality Management Systems of ISO 9001 certified Contractors

Surveillance audits

- **A quality audit is a structured and independent review to determine whether project activities comply with**
  - Organizational and project policies
  - Processes
  - Procedures
- **Key requirements**
  - A formalized process/methodology
    - Audit questionnaire to be followed
      - As per ISO 19011 standard: Guidelines for quality and/or environmental management systems auditing
  - Audit adapted to the purpose of the scope of work in terms of content, duration and auditors
  - Feedback from other projects and, if possible, from other companies and contractors
  - Being stringent on the deficiencies

Project Surveillance Plan

- **Consolidated document listing all the quality assurance and quality control activities and of their satisfactory performance**
- **Each PSP topic is co-signed by entities involved, at completion of the related activity**
- **PSP is co-signed at end of the realization & satisfactory performance of all activities**

Id No	Activity	Responsibility Executed by	Operational or Execution Specification/Procedure/ instruction	Reference document - QC Procedure - Acceptance criteria	CTR Inspection program	CPY Surveillance Program	Third Party Surveillance Program	OUTPUT Quality record
1,1					1st Party QC inspection points	2nd Party Surveillance points	3rd Party Surveillance points	•

Company surveillance points definition requires to be intrusive

Quality Surveillance Program

- **Based on Surveillance (or Inspection) activities defined in a Project Surveillance Plan, globally or per unit (package/equipment/module)**
- **Five types of surveillance or inspection points may be defined:**
  - **Information:** documents related to the execution of a relevant part of the Work are submitted to the Project for information only
  - **Review:** documents (or results of controls and/or tests performed) are submitted to the Project for review, before execution of the relevant task or part of the Work
  - **Monitoring:** project team (or a representative) attends the execution of the task, either continually or occasionally
  - **Witness:** a Project representative is expected to attend an activity but his absence at this stage does not stop the execution of the relevant part of the Work. The Supplier or Contractor is required to give an advanced notice as agreed by contract
  - **Hold:** the absence of the Project representative at this stage halts the execution of the relevant part of the Work, until reception of COMPANY release notice; Supplier or Contractor is required to give an advanced notice as agreed by contract

Example of quality Records

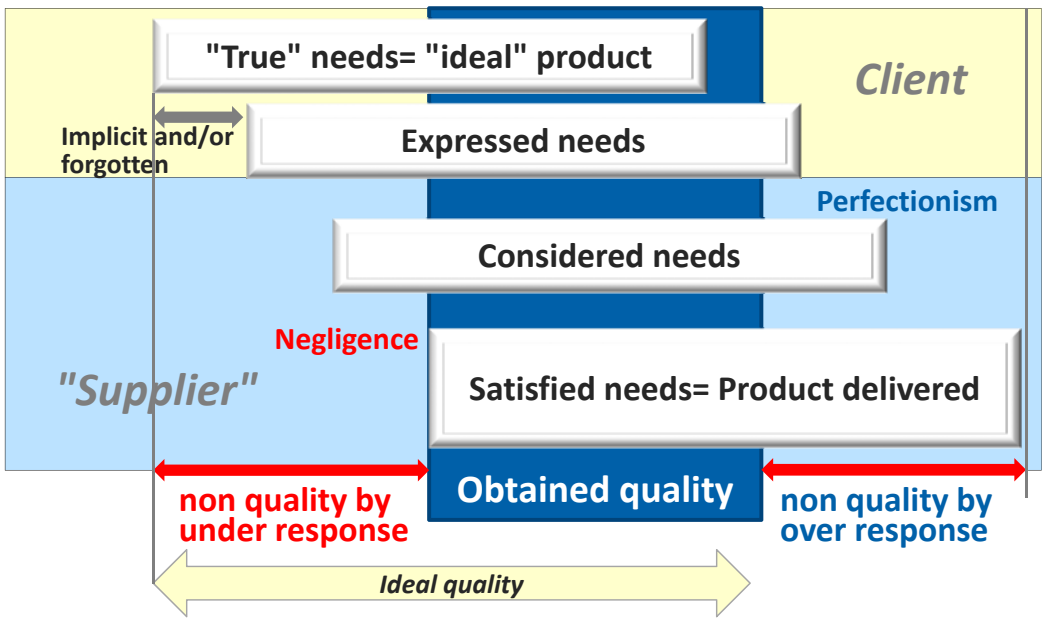
- **Approved Contractors Quality plans**
  - QC, Inspection, Test, Surveillance
- **Material certificates**
  - Mil, calibration…
- **Qualification of processes records**
  - WPS, NDT, heat treat, painting, Weld repair…
- **QC procedures and records**
  - visual inspections, NDT, check lists…
- **Survey reports**
  - vibration, alignment, weight…
- **Traceability records**
  - marking, mark-up…
- **Tracking registers/Action lists**
- **NCRs and waiver records (accepted and rejected)**
- **Third party certificates & reports**
  - design appraisals, Verifications, Classifications, Certifications, fire test, cranes…
- **Contractual certificates**
  - RFC, RFSU, Transportation, Hand-over, Load-out, Acceptance… and associated punch lists
- **Overall pre-commissioning and commissioning output and dossiers (even if also considered elsewhere)**

Summary

- **Quality starts with a proper definition of**
  - Objectives
  - Responsibilities
  - Accountabilities
  - and management procedures
- **Quality audits verify the implementation of the procedures**
- **The basic tool for quality management is the PDCA improvement loop**
- **The surveillance plan is an essential tool to check that the important/critical products meet the required specifications**

Summary

- **Reminder: Quality consists in satisfying client's needs**





Risks

Risk management

Foreword

- **Main objective**
  - Identify potential events that can have an impact on project execution in terms of
    - Time delay
    - Cost overruns
    - Quality issues
    - Accidents, incidents…

- **Main tools and means**
  - Quantitative and qualitative risk analysis
  - Risk response strategies

Risk management

- About risk
  - Risk definition
  - Why manage risks?
- Planning risk management
- Identifying risks
- Performing Qualitative Risk Analysis
- Performing Quantitative Risk Analysis
- Planning Risk Responses
- Controlling Risks

When a risk is materialized

- Causes
- Event: Deep Water Horizon Explosion & Oil Spill
- Consequences





When a risk is materialized



- **Causes**
  - Heavy Adverse weather
  - Engine failure
- **Event**
  - Vessel with EPC Contractor containers grounded (Alexandria)
  - Loss of critical equipment
- **Consequences**
  - Schedule slippage
  - Re-Manufacturing of equipment



To qualify an event as a risk it must



On the positive side opportunities can be detected



The same evaluation techniques can be used for risks and opportunities

What is Risk Management?

as per Engineering & Construction Risk Institute (ECRI)

1. **The process associated with identifying, analyzing, planning, tracking, and controlling project risks.**

2. **The life cycle process which includes identification, assessment and analysis, but adds the identification and implementation of proactive actions which are intended to mitigate risks and enhance opportunities. The management process also includes monitoring the efficiency of planned actions and the continuous update of all assessments as they change due to the implementation of actions and/or changes in the project environment with the passage of time.**

Risk Perception: Human and Enterprise Factor

BEHAVIOURAL & CULTURAL DIFFERENCES

- Risk Attitude is influenced by Appetite and Perceptions of the Project Stakeholders (Company, Contractor, Sub-Contractors, Vendors)
- View of Risk is influenced by Attitude and Perceptions of Project Team and Individuals
- Risk Averse, Risk Neutral and Risk Seeking
- There could be Cultural or Historical Aspects
- There could also be Geographic/Regional aspects

Project Risk Management Objectives

What are the objectives of risk management?



Risk management

- About risk
- Planning risk management
- Identifying risks
- Performing Qualitative Risk Analysis
- Performing Quantitative Risk Analysis
- Planning Risk Responses
- Controlling Risks

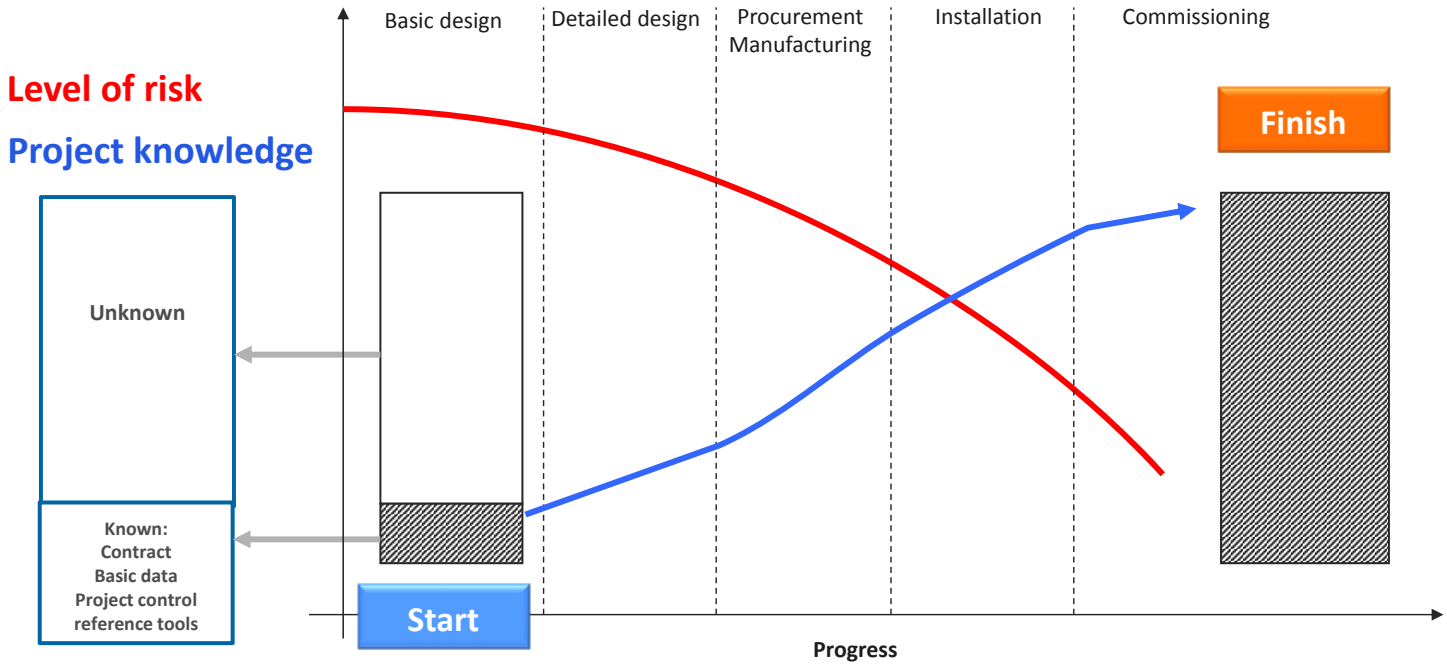
Risk assessment



Project Risk – Key Stakeholders



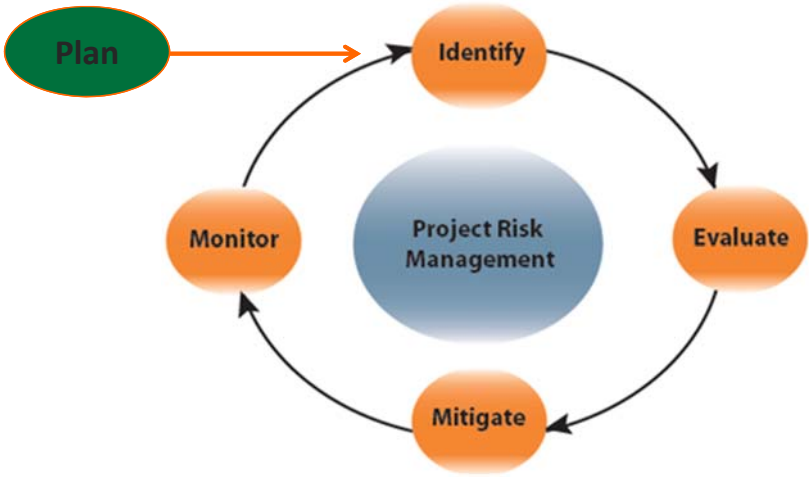
Level and typology of risk varies during Project Life



The level and the nature of the risks change with the progress of the project

Risk Management Process (APM)

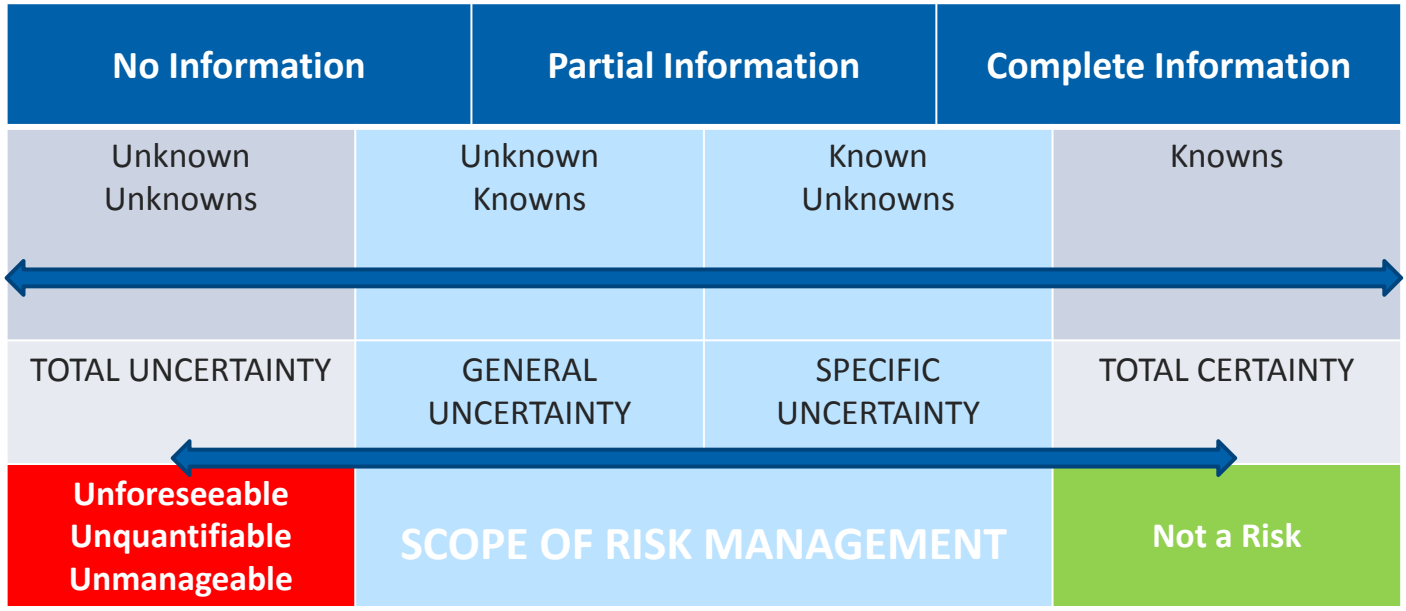
« The process whereby responses to the risks are formulated, justified, planned, initiated, progressed, monitored, measured for success, reviewed, adjusted and closed » APM



Risk management

- About risk
- Planning risk management
- Identifying risks
  - Risks characterization
  - Risks Identification
  - How to structure risks
- Performing Qualitative Risk Analysis
- Performing Quantitative Risk Analysis
- Planning Risk Responses
- Controlling Risks

Classification of Risk/Uncertainty Spectrum



Source PMI PMBOK

Classification of Risk/Uncertainty Spectrum

- **Known Unknown Risk (Specific Uncertainty)**
- **These risks include items which relate to Accuracy, Growth and Design Development of the work and elements and conditions which cannot be fully defined or assessed at the time of estimate preparation.**
  - Degree of Project definition, estimating methodology, design/take-off allowances, escalation and impact of unusual but foreseeable aspects and circumstances
- **Known Unknown Risks are covered by Allowances (allowances are part of estimating technique and in no way considered as contingency)**
- **Company experience and lessons learned are used for impact definition**

Classification of Risk/Uncertainty Spectrum

- **Unknown Known Risk (General Uncertainty)**
- **These risks include those which can be foreseen or are known to exist with varying degrees of credibility and assessed probability of occurrence**
  - Examples are subcontractors claims, out of sequence working, delivery slippage, liquidated damages, remedial work under guarantee etc.
- **Management judgment, lessons learned and qualitative/analytical tools are used to assess impact**
- **Unknown Knowns are covered by Contingency and Funded Liabilities**

Classification of Risk/Uncertainty Spectrum

- **Unknown Unknowns (Totally Uncertain)**
- **These risks include those which have never been heard of or are either so rare and unlikely as to be unforeseeable, cannot be predicted, are unquantifiable and completely outside the project stakeholders control**
  - Examples are pandemics, terrorism, economic dislodge, natural phenomenon, piracy, AIDS, regional conflicts, loss of equipment at sea, lockout, currency devaluations, strikes and the like
- **Unknown Unknowns are either avoided, insured where possible or covered by words in the contract**

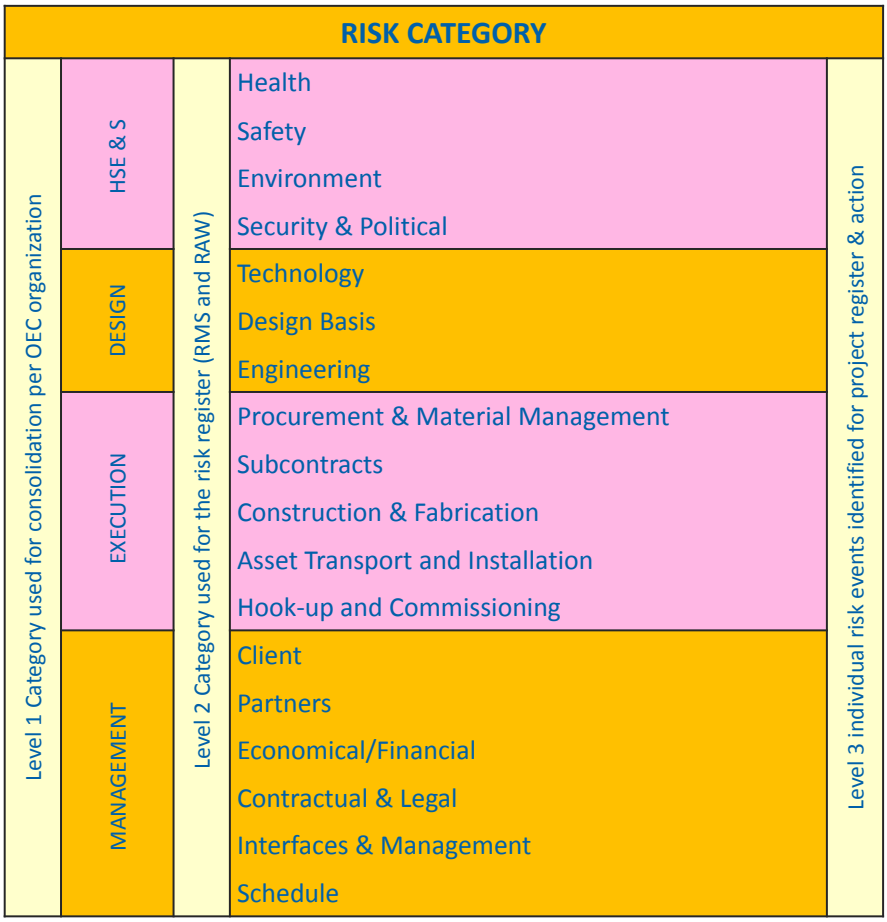
Qualitative analysis – Risks characterization



What is a RBS?

- **Risk Breakdown Structure**
  - "A RBS is a source-oriented grouping of risks that organizes and defines the total risk exposure of a project" (APM)
- **Characteristics**
  - Hierarchical
  - Descending levels are more details
  - Risks assessments can be summarized to the next level
- **Objectives**
  - Organize threats and opportunities within common framework to assess the risk exposure of a project
  - Support strategic and tactical decision making when managing risks
  - Enhance risk identification
- **Outcomes**
  - Summary reports can be generated across multiple projects
  - Project risk profiles can be compared and benchmarked
  - Risks can be categorized within a common corporate structure

Check list for risk review



Risk management

- About risk
- Planning risk management
- Identifying risks
- Performing Qualitative Risk Analysis
  - Risk probability vs impact assessment
  - Risks matrix
- Performing Quantitative Risk Analysis
- Planning Risk Responses
- Controlling Risks

Evaluate: Qualitative risk assessment

Risk Rating = **Severity** **x** **Probability**



- Very Unlikely
- Unlikely
- Possible
- Likely
- Very Likely

Evaluate – Risks Rating and Sorting

Define

Levels & Criteria

Probability of occurrence

Level	Criteria	Factor
Very low	< 10 %	1
Low	10% to 30%	4
High	30% to 70%	7
Very high	> 70%	9

Evaluate – Risks Rating and Sorting

Define levels

for each criteria

Impacts

Schedule Impact

Level	Criteria	Factor
Very low	< 1 Mois	1
Low	1 à 3 Mois	4
High	3 à 10 Mois	7
Very high	> 10 Mois	9

Cost Impact

Level	Criteria	Factor
Very low	< 50K€	1
Low	50 à 100K€	4
High	100 à 1000K€	7
Very high	> 1000K€	9

Evaluate – Risks Rating and Sorting

Criticality = Probability factor x Highest impact factor

Criticality

Risk	Probability	Impacts			Criticality
		Impact 1	Impact 2	Impact 3	
A	4	4	1	4	16
B	4	1	1	1	4
C	7	7	4	9	63
D	1	9	7	7	9
E	9	7	1	1	63
etc.					

Evaluate – Risks rating and Sorting

High criticality

Action plan needed

Medium criticality

Action plan suggested

Low criticality

Evolution to be monitored

Define the limits of the three criticalities categories

			The Higest impact			
			Very Low	Low	High	Very High
		Factor	1	4	7	9
Probability	Very High	9	9	36	63	81
	High	7	7	28	49	63
	Low	4	4	16	28	36
	Very Low	1	1	4	7	9

Apply the categories in the register and find the criticality

Risk	Probability	Impacts			Criticality
		Impact 1	Impact 2	Impact 3	
A	4	4	1	4	16
B	4	1	1	1	4
C	7	7	4	9	63
D	1	9	7	7	9
E	9	7	1	1	63
Etc.					

Establish a Risk Register with risk reducing measures

Risk ID	Package nb	Category (see worksheet "Category")	Risk title	Causes	Events	Consequences	Health & Safety	Social & Security	Environment	Schedule impact	Cost impact	Performance	Company Reputation	Severity	Probability	Risk Rating	Manageability	Criticality	Rank	Action Id	Mitigation Plan	Status
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																				13B	Be aware of delay impacts and try to minimize it by resequencing operations. Specific schedule team mobilized to consolidate the S/C schedules	On-going
																				13C	CPI delivery dates and location shall be stated in the contract. =>	Closed
																				13		On-going
64	0	Construction & Fabrication	Senior positions to be filled in (HSE, Operations, Logistic)	- Part of PMT to be mobilized in contract) - Difficult to mobilized PMT - HSE manager is leaving beguinning of June - Operation manager is leaving beguinning of July - Find replacement for Logistic manager during his rotation.	Negative feed back from CPY	- Poor interface - Delay in project progress - reputation regarding HSE management - Negative feed back from CPY impacting resolution of VOs	3	1	1	5	3	1	3	5	5	25	2	50	2	64A	Operation Manager to be nominated	Delayed
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64	0	Interfaces & Management	Interface with CPY and other contractors SPS	- Company does not have interface system and interface manager. Interface management may be slow to develop (workflow between and interface register) - Other contractors may be late to reply - Getting late information in case one change occurs on one interface.	Late reply of CPI suppliers	Action transferred to ia VO Re-work / Re-design	1	1	1	5	4	1	1	5	3	15	3	45	3	64A	Interface weekly meeting with Company and CPI suppliers to expedite interface issues. Request attendances of all CPI suppliers	On-going
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																				64E	Specific mail box to be put in place to ensure good follow-up of interfaces	Closed
																				64		On-going

Risk management

- About risk
- Planning risk management
- Identifying risks
- Performing Qualitative Risk Analysis
- Performing Quantitative Risk Analysis
  - Tools for QRA
  - Use of QRA for contingencies calculations
- Planning Risk Responses
- Controlling Risks

A simplified approach: Expected Monetary Value of risks

- Expected Monetary Value is the probability weighted average of all possible outcomes and is calculated as

$$EMV = P \times I$$

Quantitative Risk Analysis Form					
Risk	Activity	Probability	Cost Impact	EMV of the Cost	Risk moved into Plan Risk Response
14	B	30%	$60.000	$18.000	Yes
13	C	50%	$40.000	$20.000	Yes
21	B	25%	$10.000	$2.500	No
6	E	15%	($30.000)	($4.500)	Yes
15	A	15%	($90.000)	($13.500)	Yes
Total Expected Monetary Value				$22.500	

An example of EMV calculation

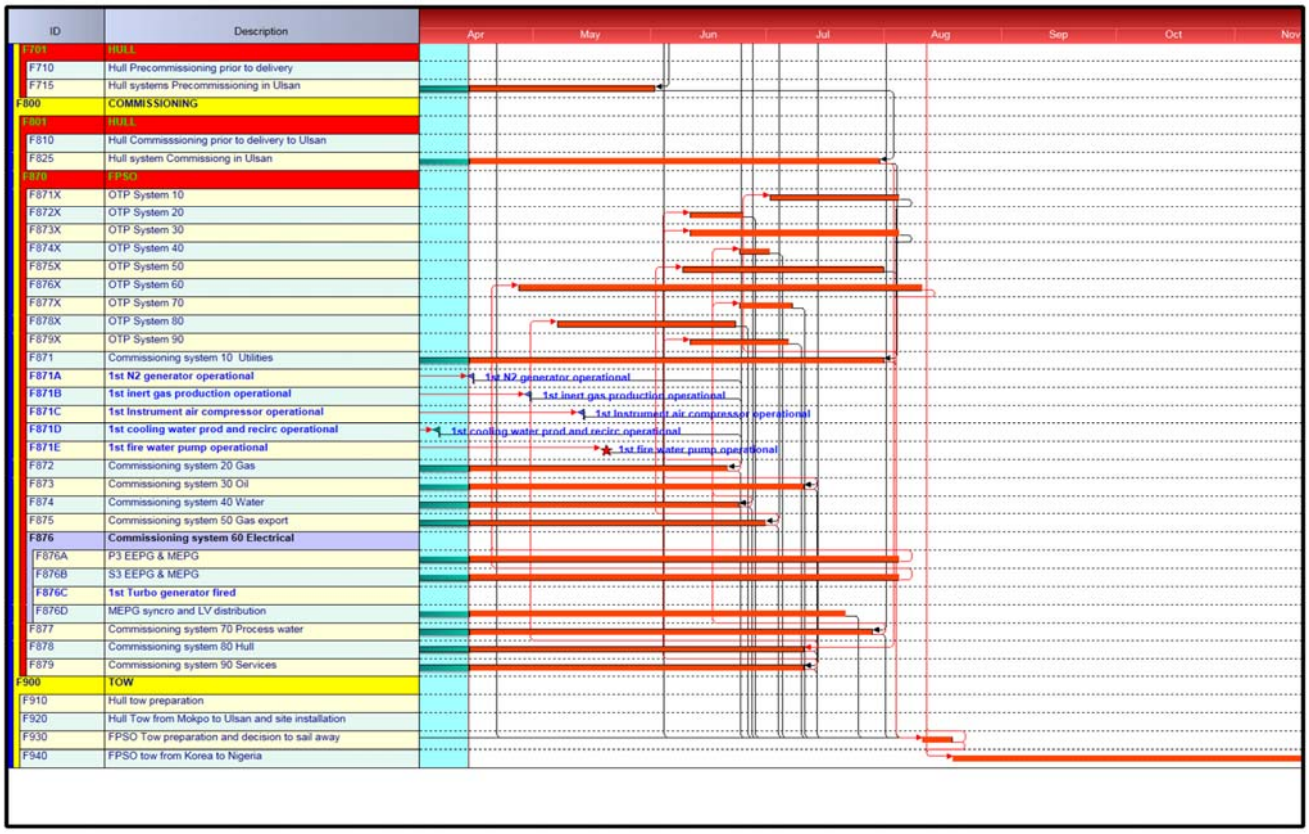
Risk n°	RISK	Financial Impact	Probability		Provision
Tech 1	Duplication or no numbering of the equipment assigned to the project in relation to equipment already on site	1 000	10%		100
Tech 2	More trucks transporting hazardous products on a single road in poor condition	500	5%		25
Tech 3	Production line break in the plant	500	10%		50
Tech 4	Start-up of critical installations without totally controlling the related risks	1 000	5%		50
Tech 5	Inadequacy of current firefighting equipment (operational fire hydrant, etc.), combined with more work and more employees	10 000	5%		500
Tech 6	Insufficent control of worksite vehicles on the worksite	500	2%		10
Tech 7	Complex local regulations for obtaining permits (land, construction, operation, etc.), further complicated by the language of the country, with frequent additions and modifications to regulations and even differences between local and French regulations (e.g. on asbestos)	10 000	50%		5000
Tech 8	Obligation to use materials/equipment certified to local regulatory standards	2 000	10%		200
Tech 9	Lack of a safety culture in the personnel of local JV, Company and subcrontactor	200	20%		40
Tech 10	Feedback insufficient to understand and control the current plant process	4 000	20%		800
Tech 11	A restrictive work environment, with PSE sometimes not adapted to the working conditions required by the company	500	5%		25
Business 1	Defective maintainability and operability of facilities designed by the project	2 000	5%		100
Business 2	Frequent changes by internal client impacting the specifications	4 000	50%		2000
Business 3	Signing of contracts before technical specifications & Legal doc issue are finalized because of fast-track planning	2 000	50%		1000
Business 4	Requirement to buy 60% of material in country and 90% of intellectual services	1 000	10%		100
Business 5	A tracky economy in country : Insolvency / availability of suppliers in time (spares, maintenance)	2 000	10%		200
Business 6	Lack of "As Constructed" technical documents to date	3 000	20%		600
orga 1	Co-activity of the operator and the project subcontractors, with procedures that are currently insufficient for the execution of the project	6 500	5%		325
strat 1	Additional scope of work (landfill, pipe & buildings revamping,…)	30 000	50%		15000
					26125

Another tool: Monte Carlo Method



Schedule quantitative analysis – Create a model

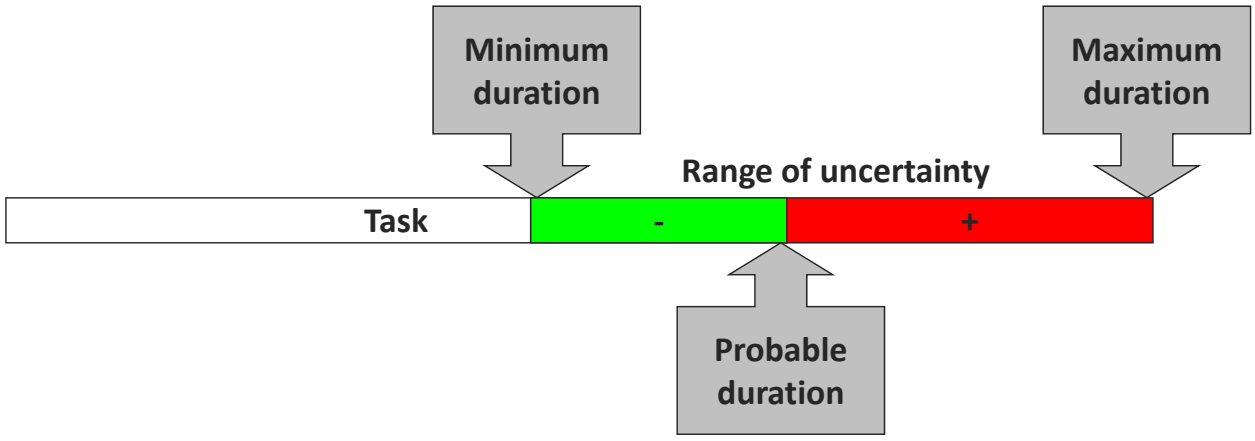
Use the project schedule or a specific schedule for the analysis



Quantitative analysis – Create a model

Duration

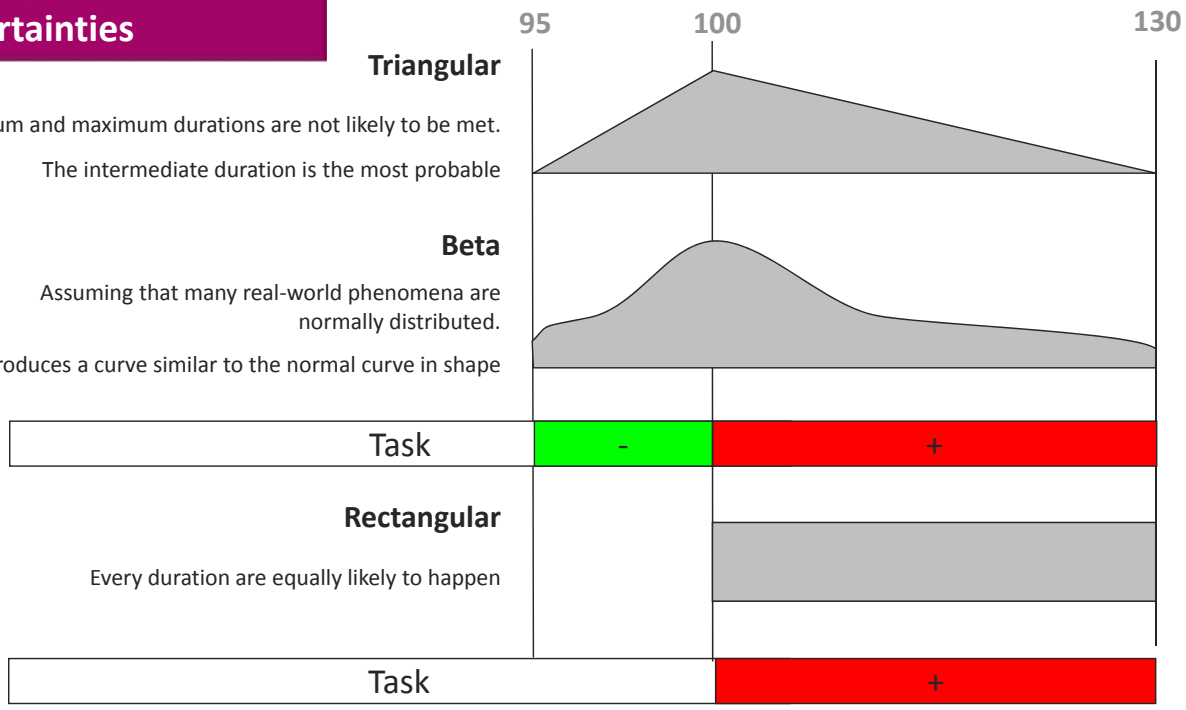
Uncertainties



Quantitative analysis – Create a model

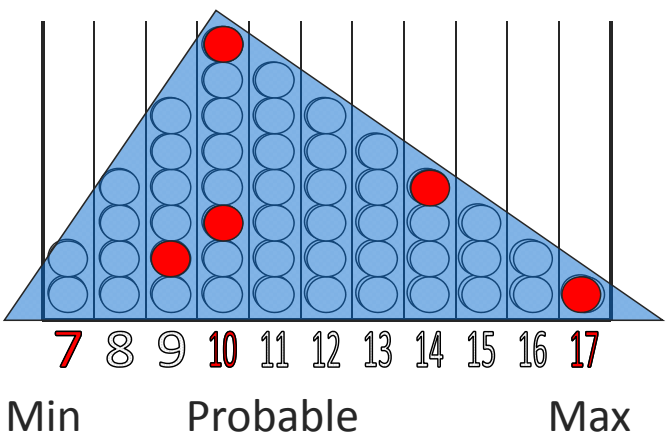
Determine the shape of uncertainty spreading
The shape is selected according to the characteristic of the uncertainty

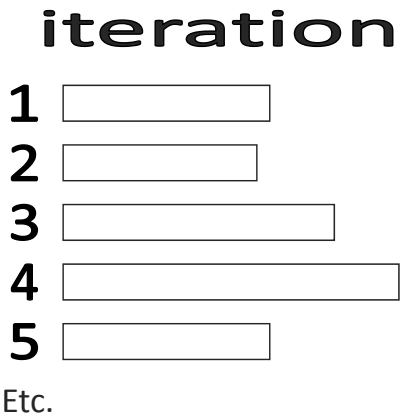
Duration Uncertainties



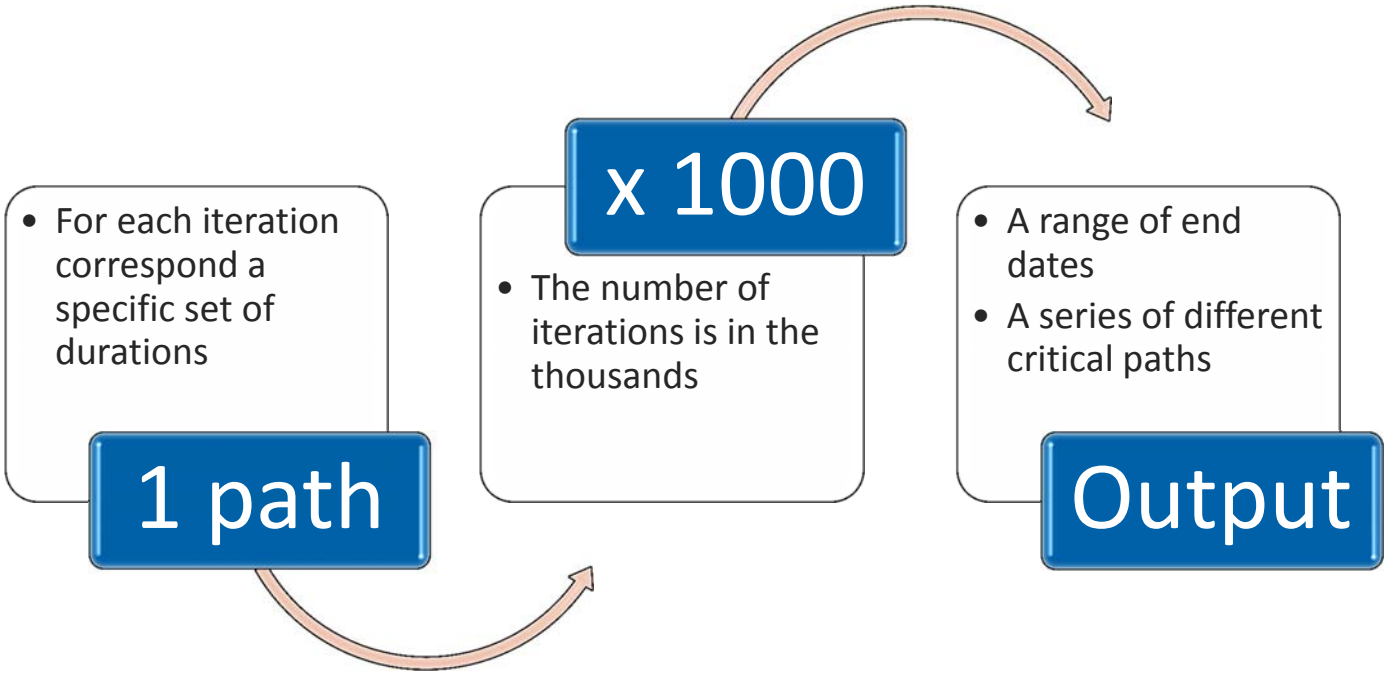
Monte Carlo simulations

During each iteration, for each task, a duration is randomly selected within the shape of the duration profile





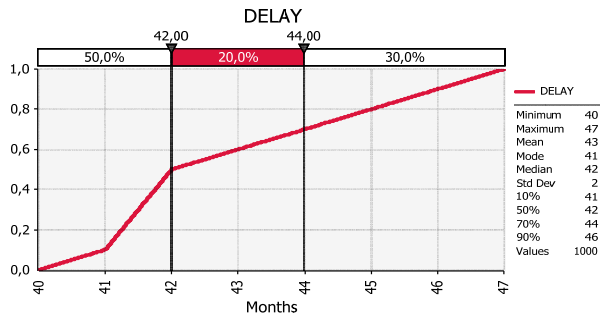
Quantitative analysis – The Monte Carlo method

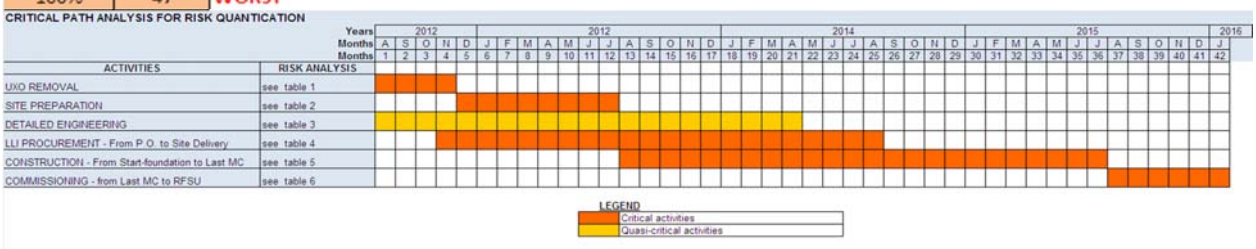


Schedule Accuracy & Risks

- **Schedule: 42 months to RFSU**
  - Schedule team performs a schedule Risk Analysis to be considered in the Cost Estimate Model

Schedule Analysis		
P	Months	
0%	40	BEST
10%	41	
20%	41,25	
30%	41,5	
40%	41,75	
50%	42	BASE SCHEDULE
60%	43	
70%	44	
80%	45	
90%	46	
100%	47	WORST

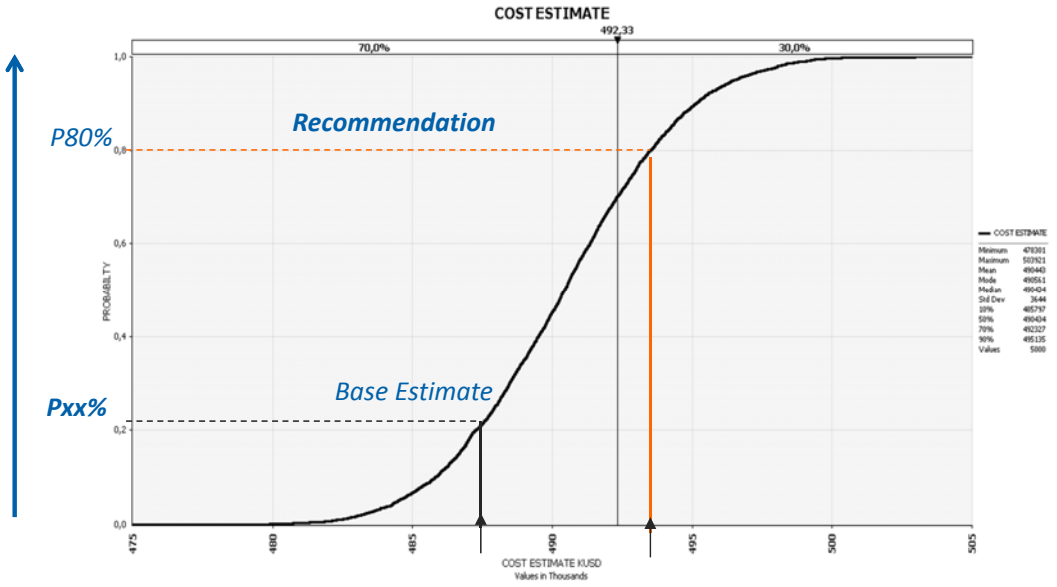




Contingency cost analysis & recommendation

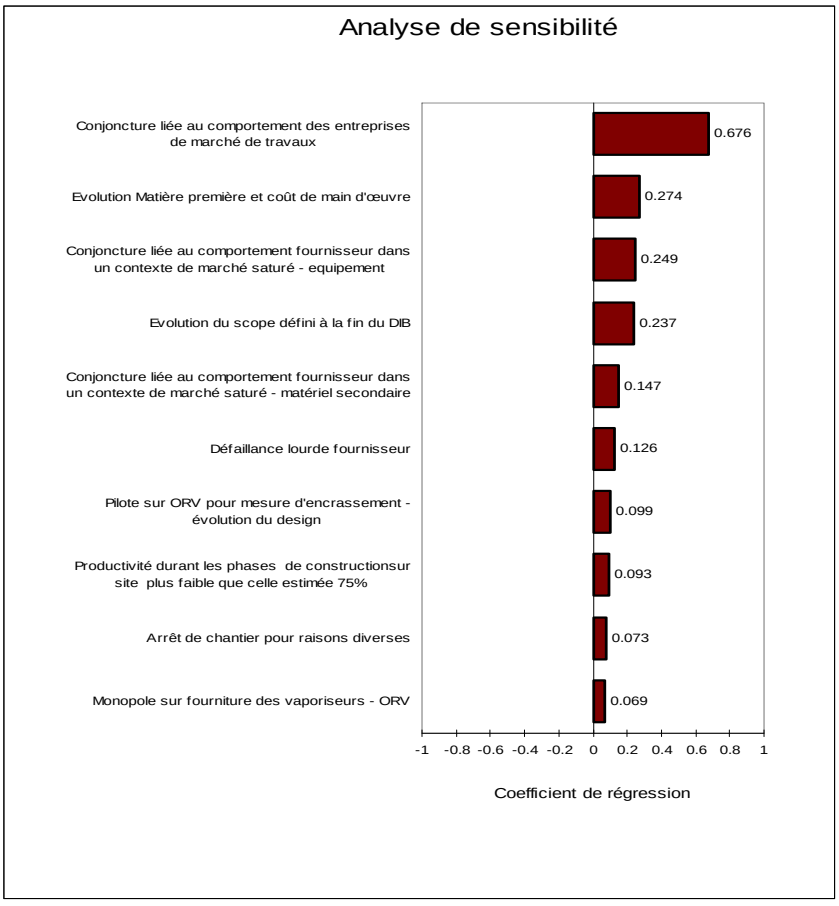
Recommendation of level of contingencies

Probability of not overrunning the base cost estimate



Δ= Contingencies in MEUR

Quantitative analysis – Cost



Level of sensibility
Level of contribution of each cost item to the overall cost

Reference tools

- **Palisade @Risk 6.0 or Oracle Crystal Ball**
  - Microsoft Excel and MsProject
  - *Used for cost modelling*



- **Oracle Primavera Risk Analysis (ex-Permaster)**
  - *Used mainly for schedule modelling*



Risk management

- About risk
- Planning risk management
- Identifying risks
- Performing Qualitative Risk Analysis
- Performing Quantitative Risk Analysis
- Planning Risk Responses
  - Generic Risk responses
  - Treatment of opportunities
- Controlling Risks

Generic Risk Response Strategies

Delete cause and/or consequence

When the risk cannot be reduced or eliminated where no action is the better option



Prevention & Mitigation: control the risk by reducing its impact or probability of occurrence

Transferring a risk to another party is often partial

Generic Risk Response Strategies

- **Avoid**
  - Eliminate the uncertainty by eliminating the causes: e.g. by not bidding, change technology, execution strategy or contract disclaimers/exclusions
- **Transfer**
  - Eliminate or reduce the threat by transferring (generally partially) to others such as partners (JV, consortium), subcontractors, vendors, insurance
- **Mitigate**
- **Accept**
  - But continue containment with « funding » of the assessed residual risk through Contingency, Funded Liability where possible

Mitigation: Examples of risk reduction

RISK	CONSEQUENCES	MITIGATIONS
• Extent of shutdown duration	• Lost of production • Extra costs	• Implement alternate to reduce the revamping activities • Optimize the design to reduce the shutdown activities • Maximize the pre-shutdown activities • Implement pre com/com activities
• Important welding activities at Site for large equipment	• Delay of construction • Extra costs	• Prepare specific execution plan • Resources to be planed and leveled
• Failure in managing equipment novelties	• Performance • Re-engineering • Re-works • Schedule slippage	• Relevant manpower • Dedicated Vendor Representatives • Available skilled staff • Reinforce supervision • Ad hoc procedures • Fine tune method statements • Detailed construction sequences

Response Planning – Golden Rules

1. Each risk must have a Risk Response Plan Overview
2. A Response Plan can be used for more than one risk
3. The effort prescribed by the plan should be appropriate for the severity of the risk
4. Plans must be timely; so start with the Critical Risks first
5. The Risk Owner should involve the team and others suitable for creating a plan
6. The plan should address known Secondary Risks
7. The plan should identify potential Residual Risk impact
8. Incorporate Response Plans into Project Execution Plans

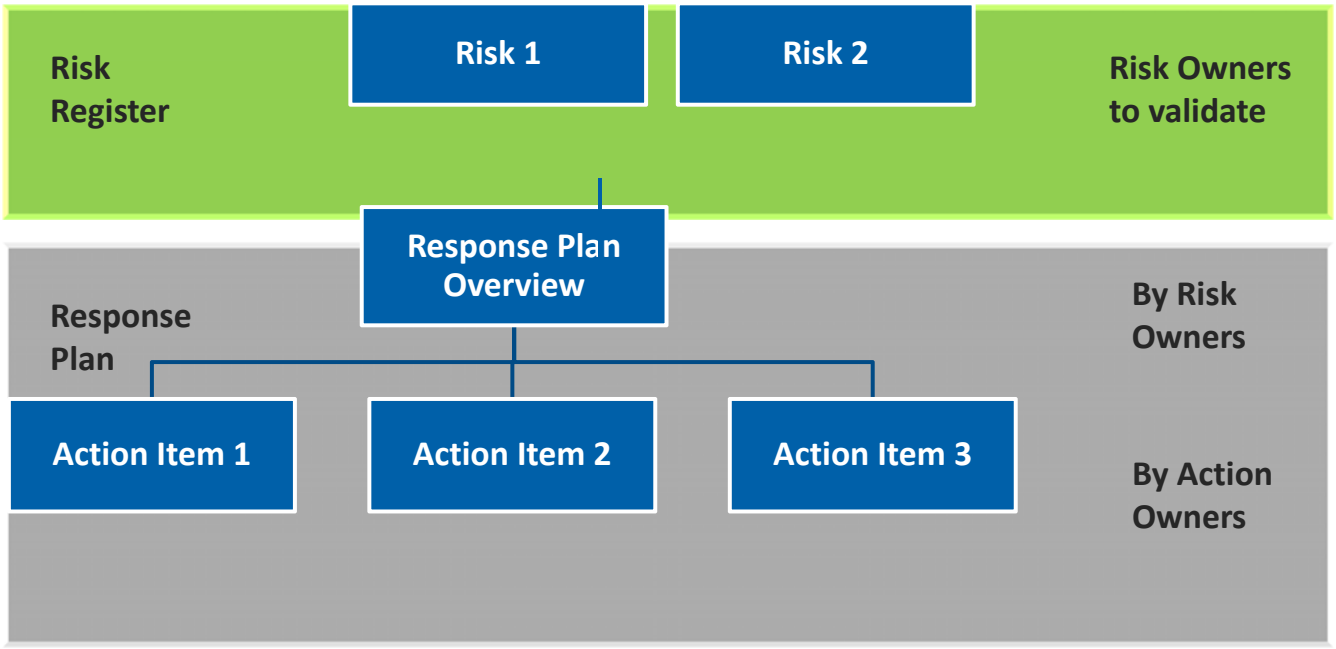
Risk management

- About risk
- Planning risk management
- Identifying risks
- Performing Qualitative Risk Analysis
- Performing Quantitative Risk Analysis
- Planning Risk Responses
- **Controlling Risks**

Monitor: Risk Register

Risk ID	Package nb	Category (see worksheet "Category")	Risk title	Causes	Events	Consequences	Health & Safety	Social & Security	Environment	Schedule Impact	Cost Impact	Performance	Company Reputation	Severity	Probability	Risk Rating	Manageability	Criticality	Rank	Action Id	Mitigation Plan	Status
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																				13C	CPI delivery dates and location shall be stated in the contract. =>	Closed
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64	0	Construction & Fabrication	Senior positions to be filled in (HSE, Operations, Logistic)	- Part of PMT to be mobilized in contract) - Difficult to mobilized PMT - HSE manager is leaving beguinning of June - Operation manager is leaving beguinning of July - Find replacement for Logistic manager during his rotation.	Negative feed back from CPY	- Poor interface - Delay in project progress - reputation regarding HSE management - Negative feed back from CPY impacting resolution of VOs	3	1	1	5	3	1	3	5	5	25	2	50	2	64A	Operation Manager to be nominated	Delayed
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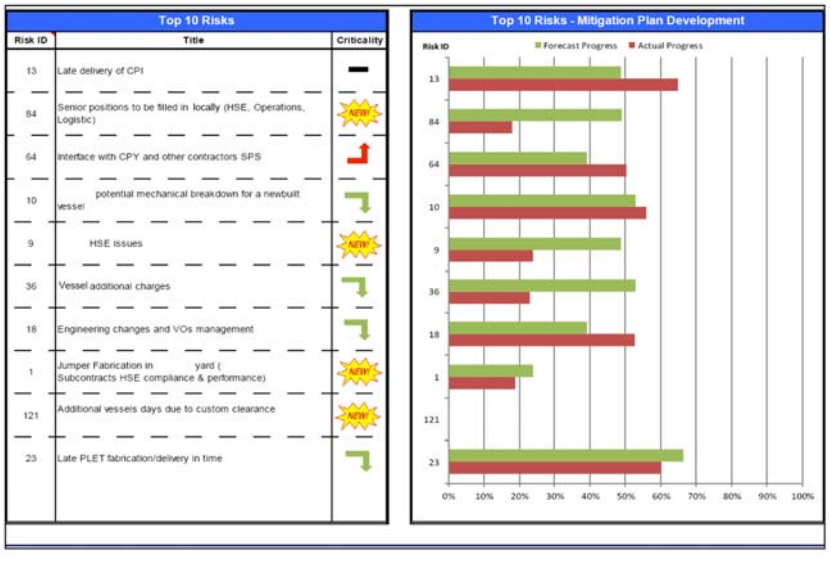
Risk Response Planning Anatomy



Follow-Up – Executive Dashboard

Top 10 with trends and progress

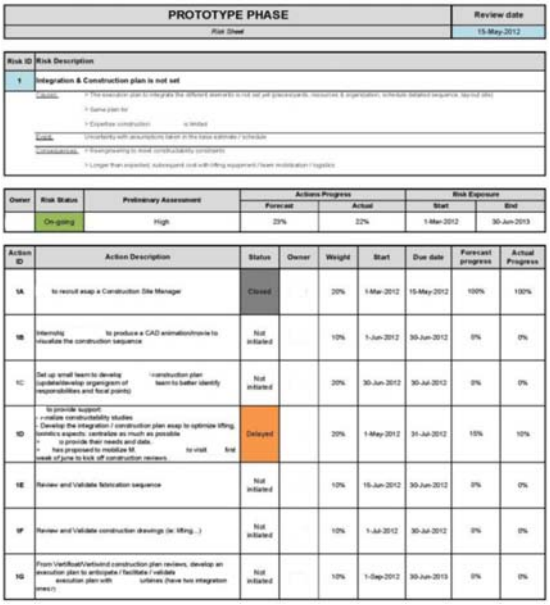
Risk Project Summary Sheet



Top 10 Risks

Risk ID	Title	Criticality
13	Late delivery of CPI	
84	Senior positions to be filled in locally (HSE, Operations, Logistic)	NEW
64	Interface with CPY and other contractors SPS	
10	potential mechanical breakdown for a newbuilt vessel	
9	HSE issues	NEW
36	Vessel additional charges	
18	Engineering changes and VOs management	
1	Jumper Fabrication in yard (Subcontracts HSE compliance & performance)	NEW
121	Additional vessels days due to custom clearance	NEW
23	Late PLET fabrication/delivery in time	

Detailed Risk Sheet



PROTOTYPE PHASE	Review date
Risk Sheet	15-May-2012

Risk ID	Risk Description
1	Integration & Construction plan is not set

Owner	Risk Status	Preliminary Assessment	Actions Progress		Risk Exposure	
			Forecast	Actual	Start	End
	On-going	High	23%	22%	1-Mar-2012	30-Jun-2013

Action ID	Action Description	Status	Owner	Weight	Start	Due date	Forecast progress	Actual Progress
1A	to recruit asap a Construction Site Manager	Closed		20%	1-Mar-2012	15-May-2012	100%	100%
1B	Internship to produce a CAD animation/movie to visualize the construction sequence	Not initiated		10%	1-Jun-2012	30-Jun-2012	0%	0%
1C	Set up small team to develop / update/develop organigram of responsibilities and focal points) construction plan team to better identify	Not initiated		20%	30-Jun-2012	30-Jul-2012	0%	0%
1D	to provide support; - realize constructability studies - Develop the integration / construction plan asap to optimize lifting, - to provide their needs and date, - has proposed to mobilize M to visit first week of june to kick off construction reviews	Delayed		20%	1-May-2012	31-Jul-2012	15%	10%
1E	Review and Validate fabrication sequence	Not initiated		10%	15-Jun-2012	30-Jun-2012	0%	0%
1F	Review and Validate construction drawings (ie: lifting...)	Not initiated		10%	1-Jul-2012	30-Jul-2012	0%	0%
1G	From Vertical/Vertex/nd construction plan reviews, develop an execution plan to anticipate / facilitate / validate execution plan with	Not initiated		10%	1-Sep-2012	30-Jun-2013	0%	0%

Detailed Risk Sheet: Action sheet

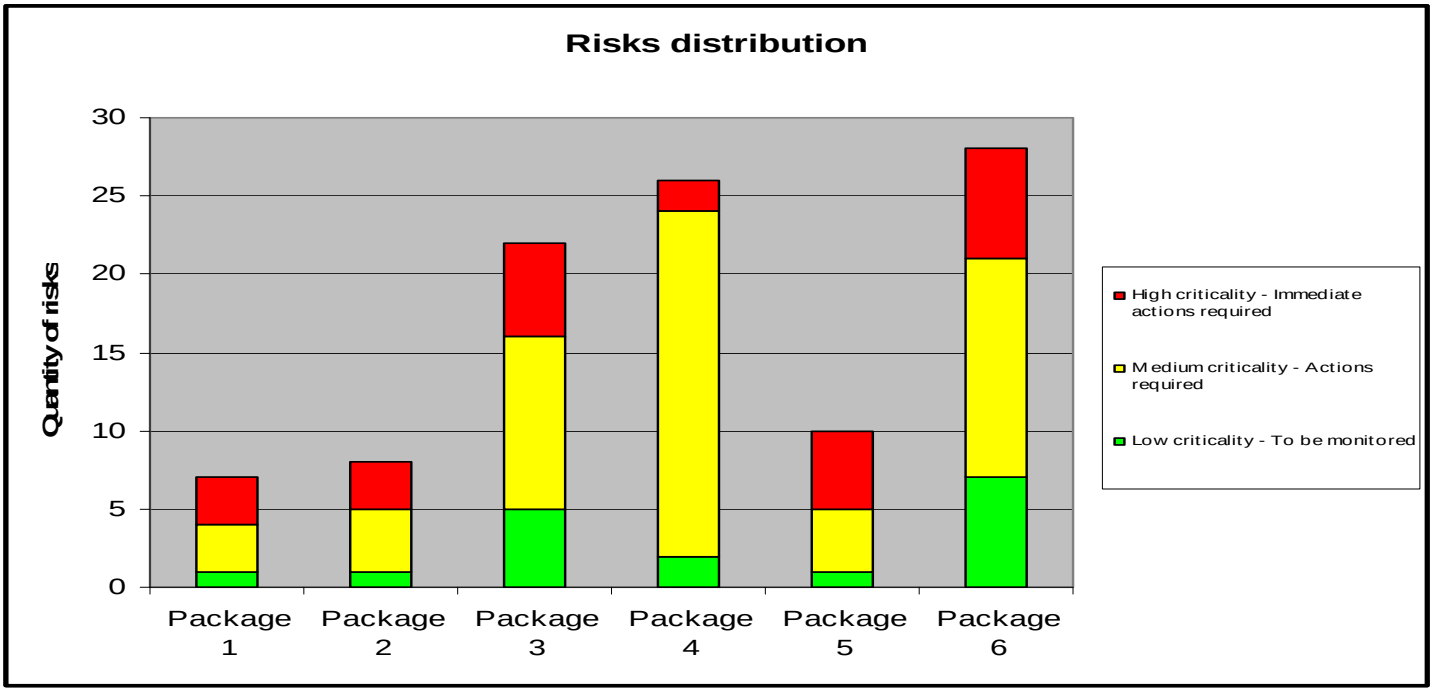
		NIGERIA - OML 130 AKPO Field Development Project Risk Identification Sheet		Date : 18/06/08 Rev. : D	
			Owner :	CALDER	
Risk ID:	M040	Interface with packages:		Status :	Open
Title:	Lack of Facilities for offshore work				
Description:	Facilities such as Flotel, boats are not available for offshore work, especially offshore commissioning or capacity/quantity are not in accordance with project expectations				
Causes:	Bad estimate of required capacity Late contracting Lack of adequate means				
Consequences:	Offshore work delayed or duration increased Few competitors with higher prices				

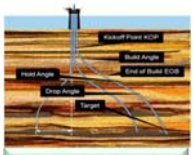
Mitigation plans / Owner	Action	Status / Date
1 -	Perform audit on critcal elements requiring alternative source of supply	01/10/2008
2 -		
3 -		
4 -		
5 -		
6 -		
7-		
8 -		

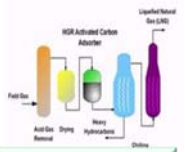
Probability target:	VL	Impact:	Cost	M
			First oil Schedule	M
Criticality Target:	4		Ramp up Schedule	M

Notes:

Follow-Up – Executive Dashboard




Package 1


Package 2


Package 3

Package ...


Package n

Summary

- A risk management plan has to be in place from the earliest phases of the project (concept selection)
- Identified risks should be compiled in a risk register shared by all project actors
- A specific organization involving both owner and contractors must be established to monitor progress of the actions related to risk reduction
- Qualitative risk analysis techniques can be used to focus the risk reduction effort on the most important issues
- Quantitative risk assessment techniques are a powerful tool to calculate the level of project contingencies to be added to the budget



Foreword

- **Main objective**
  - Keep project expenses within the allocated budget
- **Main tools and means**
  - Accurate project cost estimates
  - Cost control techniques

Objectives of the module

- **Explain how development costs are structured to form the project cost estimate**
- **Understand the methods used at different stages in the project both by Company and by the contractors to define the cost estimate**
- **Understand how the project budget is formed and the provisions added to cater for uncertainties in the cost estimates**
- **Explain methods used to estimate the Value Of Work during project execution**
- **Explain how to forecast the cost final estimate**

Cost management

- **About cost management**
- Planning cost management
- Estimating costs
- Determining budget
- Controlling costs

Objectives of cost estimation

- **Cost estimation provides input data for**
  - The economic calculations used during the decision making process prior to project sanction
  - The establishment of project budget CAPEX
  - The analysis of offers submitted by potential contractors
- **By definition, an estimate is based on uncertain input data**
- **However, the amount of uncertain data decreases during the various phases of a project as technical definition of the Project increases**
- **A Basis of Estimate (BOE) shall be produced along with the estimate**
  - It is a fundamental document that reminds the scope of the Project and explains how the estimate was produced with regards to this scope
  - It shall therefore help understanding and assessing the estimate
- **Each estimate produced comes along with estimate class that reflects the estimating methods used, the necessary input and expected accuracy**
  - The AACEi is the worldwide reference used to classify estimates in a scale from 1 to 5

Cost management

- About cost management
- **Planning cost management**
- Estimating costs
- Determining budget
- Controlling costs

Planning cost management

Input

- Project Management Plan
- Work Breakdown Structure and Organizational Breakdown Structure
- Risk management Plan

Tools & Techniques

- Expert judgment
- Analytical techniques
- Probabilitic approaches (see risk module)
- Meetings

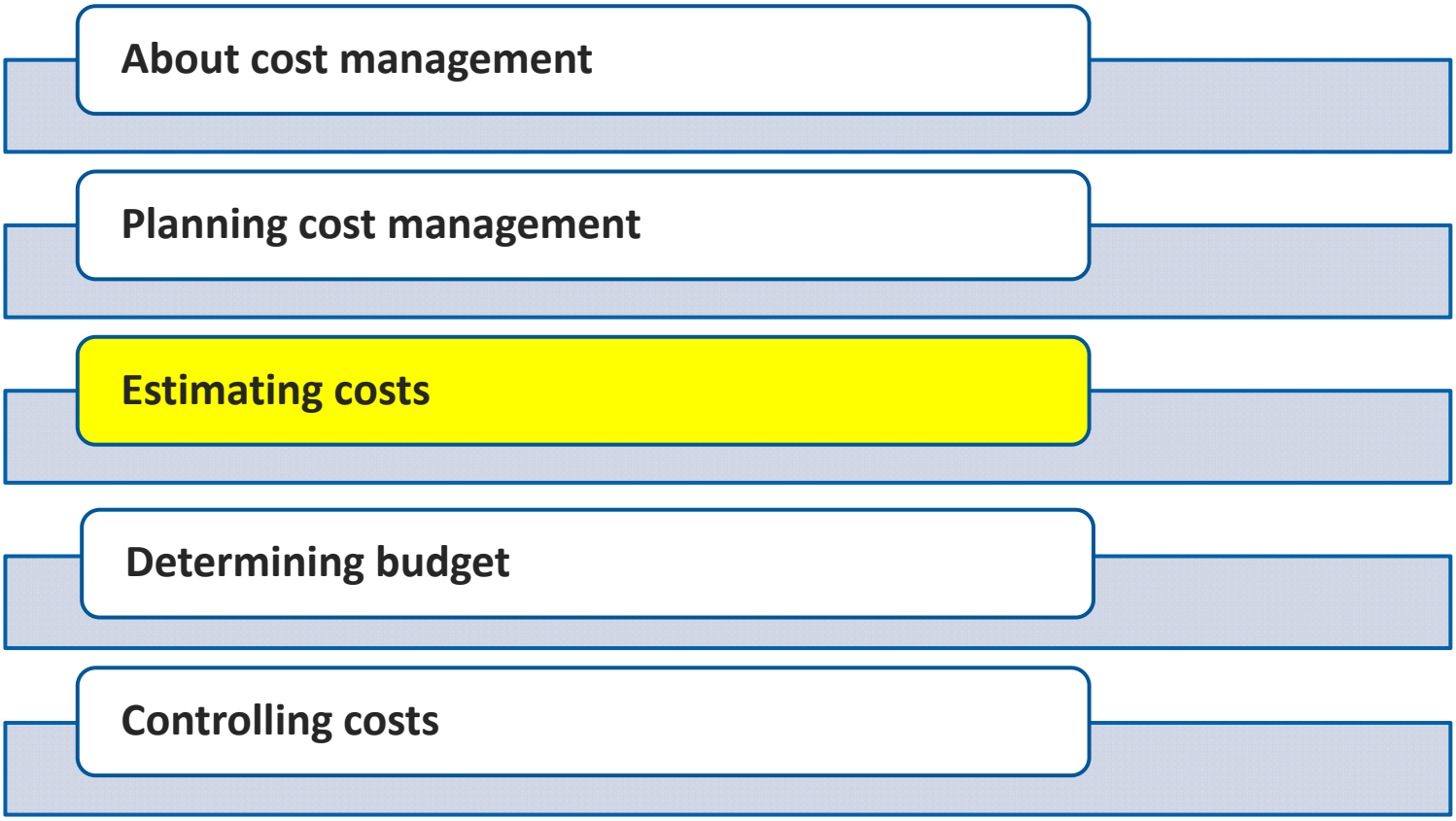
Output

- Cost management Plan

Content of the cost management plan

- **Should define the key milestones for cost estimates definition**
- **At each stage of the project a Basis of Estimate document should be prepared, defining:**
  - Units of measure
  - Level of accuracy of the cost estimates
  - Organizational procedures links
  - Control thresholds
  - Rules for performance measurements
  - Reporting formats and frequency
  - Rules for use of technical allowances, contingencies and management reserves
  - Cost validation principles

Cost management



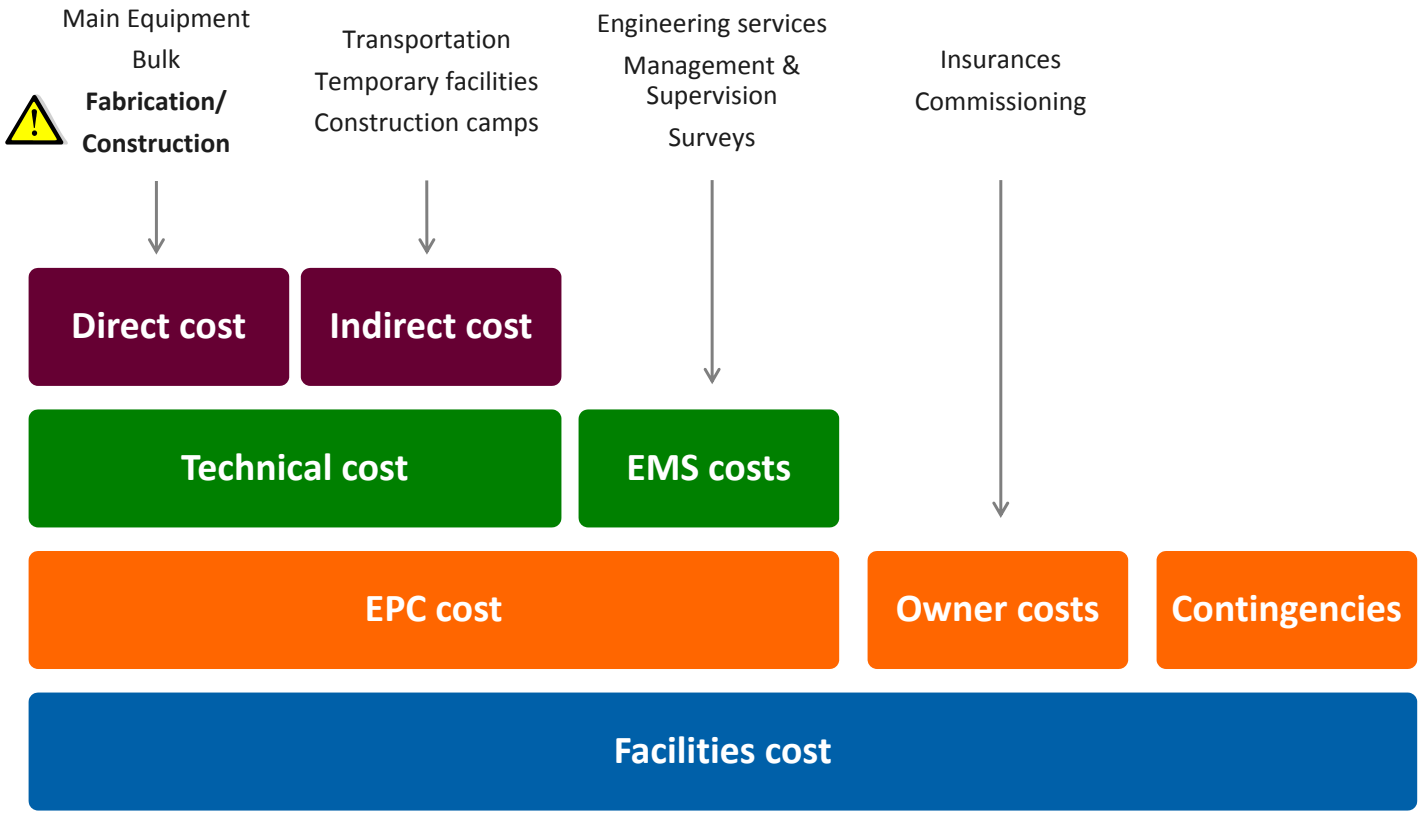
Input data to a cost estimate

- **Technical definition**
  - The more accurate the better are the chances to get a result close to the actual cost (… only known at the end of the project)
- **Historical/statistical cost data from past projects**
  - Feedback to populate data bases is essential
- **External information**
  - Quotations from suppliers
  - Applicable tender information from current projects
- **Use of commercial cost estimating software**
  - To be used with caution since the database and calculation method are often unknown and the resulting estimate may carry a high inaccuracy
  - Should be used to cross check estimates already produced with other methods rather than standalone ones

Cost components

- **CAPEX = FACILITIES + DRILLEX**
  - FACILITIES EXPENDITURES
    - Process units
    - Utilities storages & general facilities
    - Commissioning & S.U. Spare parts
    - Engineering/Project costs
    - Process licenses fees & royalties
    - Owner costs
    - Abandonment costs
  - DRILLEX
    - Drilling of wells (production, injection)
    - Completion of wells
- **OPEX**
  - Operation
  - Maintenance, obsolescence, inspections
  - Logistics
  - Chemicals, consumables

Breakdown of facilities expenditures



Breakdown od drilling expenditures

- **Well costs**
  - Preliminary site preparation works
  - Rig cost (per day)
  - Services (cementation, fluids, mud, logging…)
  - Consumables
  - Logistics and transportation
  - Supervision
  - Insurances
  - Remote logistic base
- **Other Drillex**
  - Work overs
  - Taxes and custom duties
  - Mobilization and demobilization
  - Rig inspection, modifications
  - Abandonment and site restitution

Usual Exclusions of CAPEX



- **Two-year spare parts (included in OPEX)**
  → *However, commissioning & start-up spare parts, RFSU and SU costs are included in the estimate available at the end of the conceptual study*
- **Taxes, custom duties, harbor fees**
- **Pre-operation costs (training of operators, first fill of chemical products…)**
- **Hot works interfaces**
- **Operation costs (OPEX)**
- **Escalation (inflation), exchange rates variations and currency variations**
- **Finance fees**
- **General expenses of local operating subsidiaries**
- **Risks covered by insurances**
- **Abandonment costs unless specifically included**
- **This list is a deliverable to be produced along with the estimate**

Components of operating expenditures

- **Fixed costs (given for example in US$/year)**
  - Manpower/Labor
  - Inspections and maintenance
  - Workover and well maintenance
  - Logistics (including transportation)
  - Taxes and insurances
  - Overheads
- **Variable costs (given for example in US$/bbl)**
  - Chemicals
  - Utilities (electricity, steam, fuel, water…)

Estimating costs

Input

Tools & Techniques

- **Expert judgment**
- **Estimating techniques depending on the project phase**
- **Contingency and management reserves definition methodologies**
- **Benchmarking techniques**

Output

Estimating costs by relying on expert judgement

- **As already explained, historical data is essential to prepare accurate cost estimates**
- **In addition to this, expert judgement is necessary to:**
  - Identify similar past Projects in terms of contents, environment and execution conditions
  - Retrieve pertinent data from these Projects to be used as input for the cost estimate to be performed
  - Correct this data in terms of location and date so that it remains applicable with the aim of producing a reliable estimate
  - Select, if required, a combination of estimating methods

One estimation method for each decision stage

Prospect → Preliminary Studies → Conceptual Studies → Pre-Project → Project Execution

General characteristics
Overall ratios
Benchmarks

Equipment list
Factorizations

Detailed equipment
Bulk quantities
and Construction specific MTOs







Global methods
AACEI's Class 5

Factored
Class 4

Semi-detailed methods
Class 3

Detailed methods
Class 2

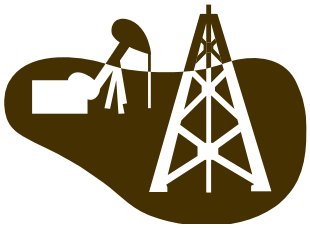
One estimating technique for each project phase:

Prospect/preliminary studies: Global methods

- **Global methods are used at the earliest stages of the Project**
- **They require little information about the Project**
- **The total cost of the Project (or the cost of its main packages) is estimated with a global method (i.e. without producing any cost breakdown)**







Similar facilities already completed
Capacity = C_1
Investment = I_1

New facilities to be built
Capacity = C_2
Investment = $I_2 = I_1 \times \left(\frac{C_2}{C_1}\right)^x$

Chilton's formula

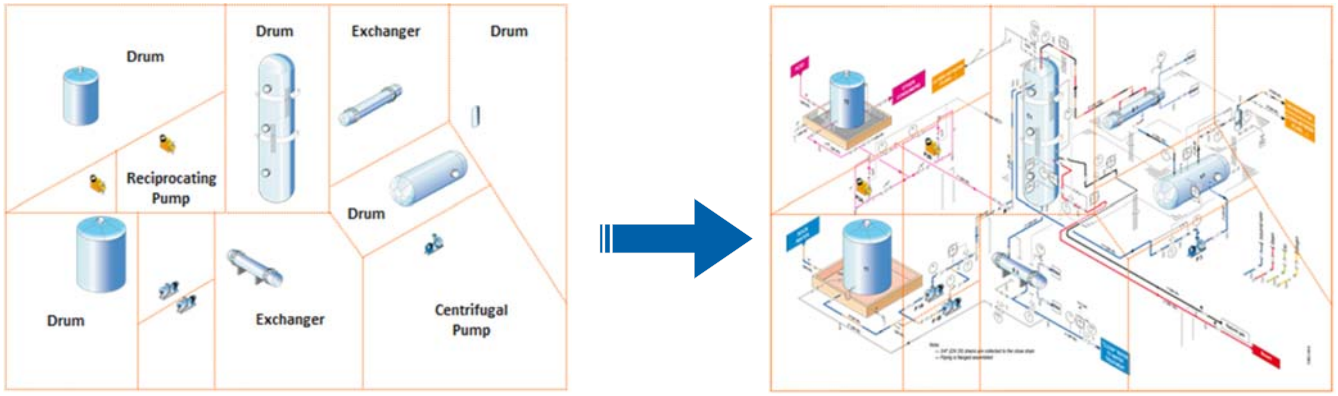
Where x is usually comprised between 0.5 and 0.8

Calculation may also take into account localization factor and actualization of dates

One estimating technique for each project phase:

Preliminary/Conceptual studies: Modular methods

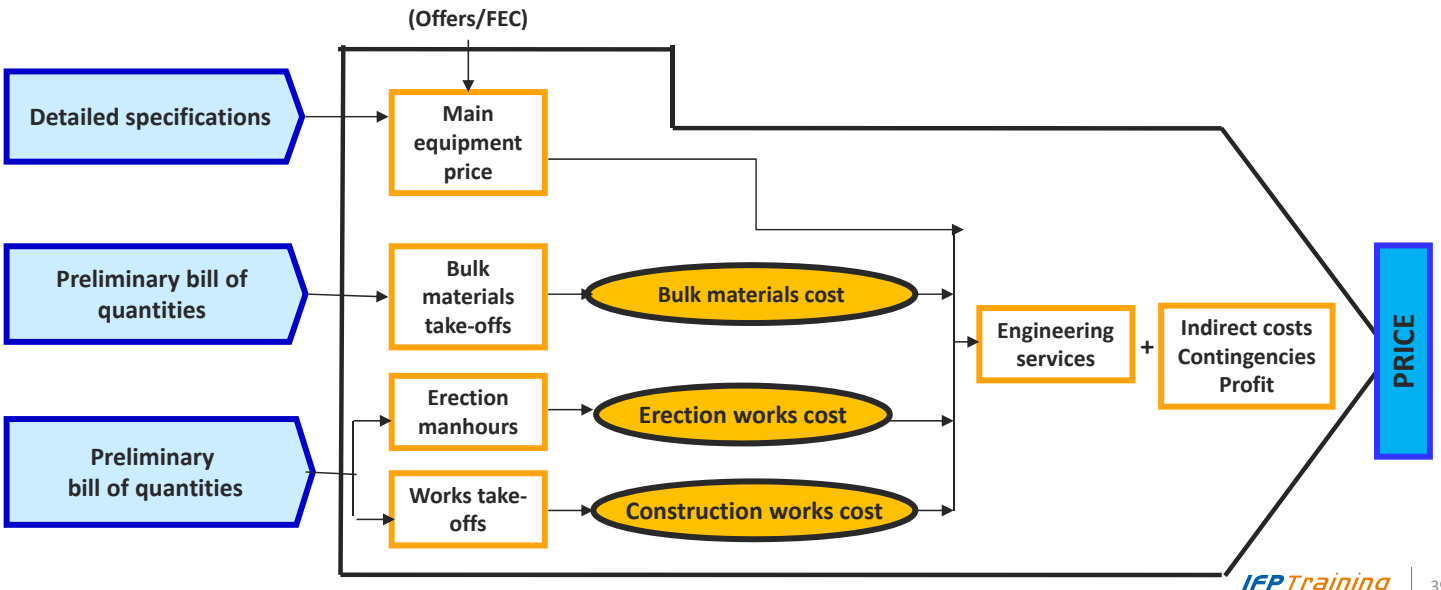
- Modular methods are used once the main equipment list becomes available
- Facilities are then considered as an addition of modules each of them featuring one piece of main equipment
- The cost of each module is obtained by applying a standard factor to the cost of the piece of equipment featured in it
- The aggregated cost of these modules gives the total cost of the facilities



One estimating technique for each project phase:

Pre-project: Semi-detailed estimating methods

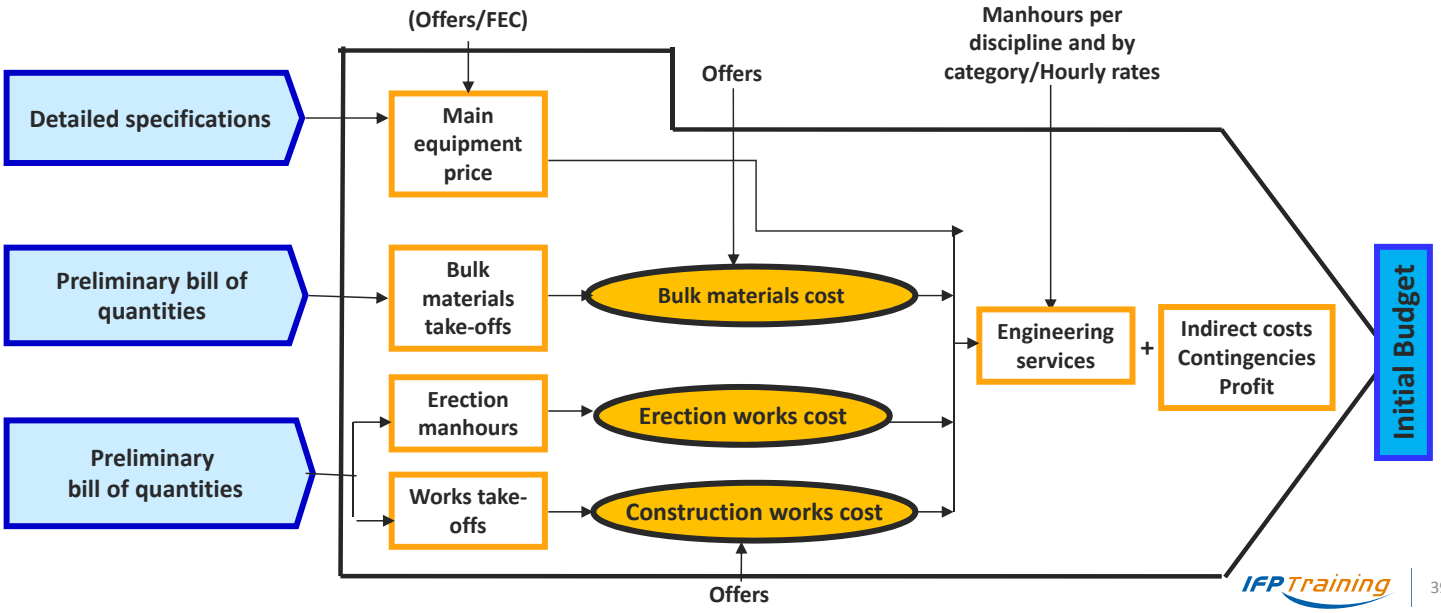
At the end of the FEED, instead of using factors to estimate most of the costs from the cost of main equipment, the newly available deliverables, along with some cost ratios, are used by Company to improve the accuracy of the cost estimate



One estimating technique for each project phase:

Detailed studies: Detailed estimating methods

Bidders can achieve even more accuracy than the Company by virtually using no ratios and detailing all costs instead



Turn key contract cost estimating by Contractor

- **Provisions are added to the cost estimate to cover for:**
  - Uncertainties on quantities (MTO), depending on the methods/reference documents used to prepare the estimate
  - Possible project growth, i.e. which does not appear on the drawings/information available to prepare the estimate
  - Extra works which will be most likely required by construction contractors working on unit price
- **Vendor proposals will be compared and contingencies for technical uncertainties and/or buy-outs (positive or negative) will be evaluated**
- **A risk assessment will be performed to take into account risks associated with the completeness and quality of the basic engineering studies (FEED), the validity of offers submitted by vendors and sub-contractors, reliability of available basic data (for soil and environment, etc.)**

Turn key contract cost estimating by Contractor

- **Contingencies will be added to cover risks associated with:**
  - Project performance
  - Schedule risks
  - Other risks
- **Contractual payment conditions will be reviewed based on the expenses curve and financial exposure risks will be assessed**
- **Meetings will be organized with Contractor management and/or JV partners to review and endorse the cost estimate**
- **Anticipated profit will be added to the calculated cost**

Accuracy ranges vs Project progress

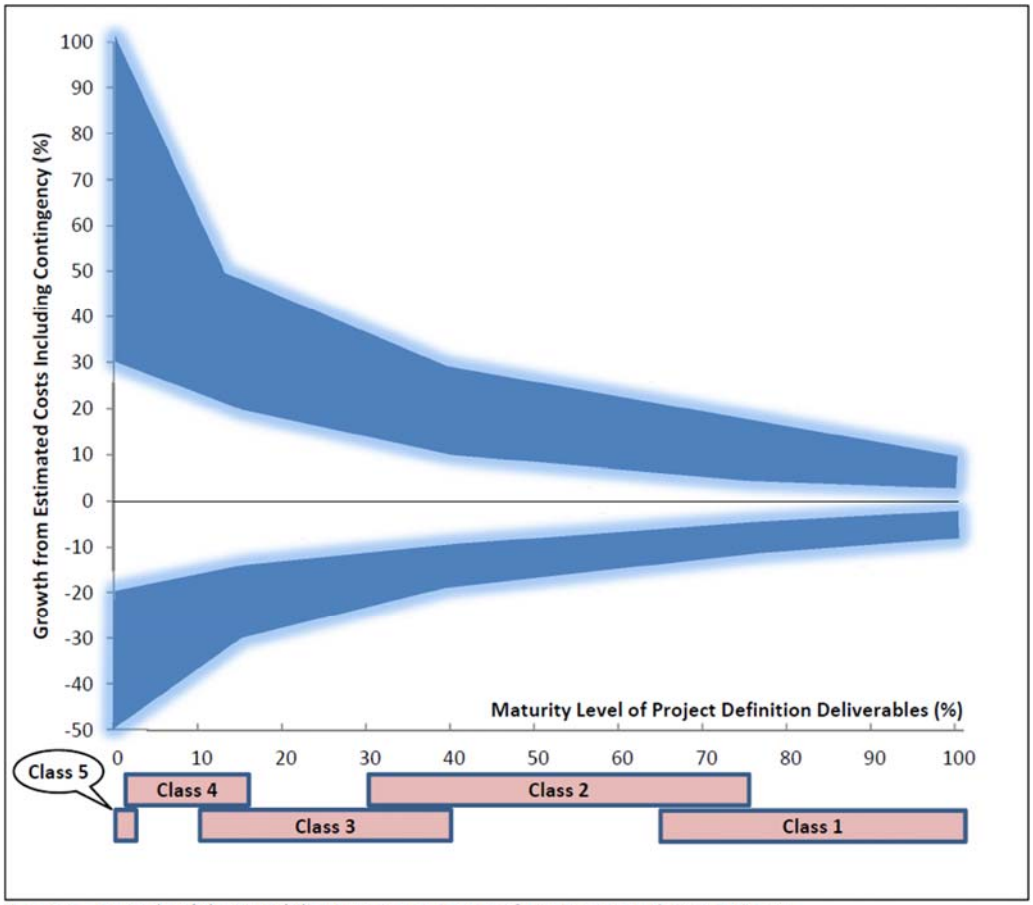


Figure 1 – Example of the Variability in Accuracy Ranges for a Process Industry Estimate

Estimating basis

	ESTIMATE CLASSIFICATION				
General Project Data:	**CLASS 5**	**CLASS 4**	**CLASS 3**	**CLASS 2**	**CLASS 1**
Project Scope Description	General	Preliminary	Defined	Defined	Defined
Plant Production/Facility Capacity	Assumed	Preliminary	Defined	Defined	Defined
Plant Location	General	Approximate	Specific	Specific	Specific
Soils & Hydrology	None	Preliminary	Defined	Defined	Defined
Integrated Project Plan	None	Preliminary	Defined	Defined	Defined
Project Master Schedule	None	Preliminary	Defined	Defined	Defined
Escalation Strategy	None	Preliminary	Defined	Defined	Defined
Work Breakdown Structure	None	Preliminary	Defined	Defined	Defined
Project Code of Accounts	None	Preliminary	Defined	Defined	Defined
Contracting Strategy	Assumed	Assumed	Preliminary	Defined	Defined
Engineering Deliverables:					
Block Flow Diagrams	S/P	P/C	C	C	C
Plot Plans		S	P/C	C	C
Process Flow Diagrams (PFDs)		S/P	P/C	C	C
Utility Flow Diagrams (UFDs)		S/P	P/C	C	C
Piping & Instrument Diagrams (P&IDs)		S	P/C	C	C
Heat & Material Balances		S	P/C	C	C
Process Equipment List		S/P	P/C	C	C
Utility Equipment List		S/P	P/C	C	C
Electrical One-Line Drawings		S/P	P/C	C	C
Specifications & Datasheets		S	P/C	C	C
General Equipment Arrangement Drawings		S	P/C	C	C
Spare Parts Listings			S/P	P	C
Mechanical Discipline Drawings			S	P	P/C
Electrical Discipline Drawings			S	P	P/C
Instrumentation/Control System Discipline Drawings			S	P	P/C
Civil/Structural/Site Discipline Drawings			S	P	P/C

S= started P= In Progress C= Completed

Cost management

- About cost management
- Planning cost management
- Estimating costs
- **Determining budget**
- Controlling costs

Initial Budget

- **An Initial Budget is prepared in accordance with the Cost Breakdown Structure (CBS). It is controlled until final completion (whether on Company side, or on Contractor side).**
  - Once the Cost Estimate is ready and the Project agreed by the Operator and the Partners (Project sanction), the Initial Budget Rev 0, is finalised. It becomes the Life of Project (LOP) Budget.
  - The Initial Budget may require adjustments during the Project Life: either for the transfer of a provision or a budget line from one Package to an other, or the deletion/addition of one budget line. The amended Budget becomes the Revised Budget
  - The budget will include provisions
  - At the end of the Project or at any time, if uncertainties become fixed, the budget contingencies may be reduced.

Provisions to be added to the base costs

- **Allowances**
  - Resources for requirements which are known to exist, but have little or no scope definition (AACEi)
  - They shall be allocated to specific items featured in the Technical Cost
  - Allowances are not contingencies
- **Contingencies**
  - Amount to cover uncertainties in the estimate which are likely to occur, but which cannot be specifically identified at the time the estimate is prepared
    (R. WESTNEY - Managing the Engineering and Construction)
  - Their use is subject to approval at Project level
- **Management Reserve**
  - Amount reserved by the Top Management of the Company beyond the overall facilities cost
  - Their use is subject to approval at Corporate level

Contingencies

Events contingencies cater for

- **Errors of the estimation model**
  - estimation models are based on mean values of the various parameters
- **Uncertainties on unit costs**
- **Uncertainties on quantities**
- **Possible variations of the workforce**
- **Variations of productivity**
- **Evolution of the market price**
- **Risks associated to the selected process**
- **Minor changes of design**

Focus on contingencies

Contingency provisions DO NOT cater for

- **Exclusions of the estimate**
  - refer to the above “CAPEX Usual Exclusions”
- **Change in scope or in Basis of design**
  - architecture, treatment capacity, effluent composition at the inlet and outlet of the installation, change in technology…
- **Process design modifications**
  - acid gas vs. sweet gas, turbo-expander vs. JT valve…
- **Exceptional stand-by**
  - weather: environment harsher than expected by installation criteria
  - exceptional delay of equipment delivery leading to stop the construction activities…

Focus on contingencies

Contingency provisions DO NOT cater for

- **Major changes to the contractual strategy**
  - EPC type contract vs reimbursable basis contract, changing the construction yard...
- **Main planning changes**
  - additional mob/demob due to delay, reduced construction schedule requiring the mobilization of extended workforce and impacting productivity, additional supervision costs, simultaneous construction and production due to a delay…
- **Major market effects, lack of competition**
  - embargo, single source…
- **Major risks**
  - war, strike, earthquake, hurricane…
- **Force majeure cases as specified in contract documents**
  - bankruptcy, failure of the contractor or the partner

Focus on contingencies

Two main ways to calculate contingencies

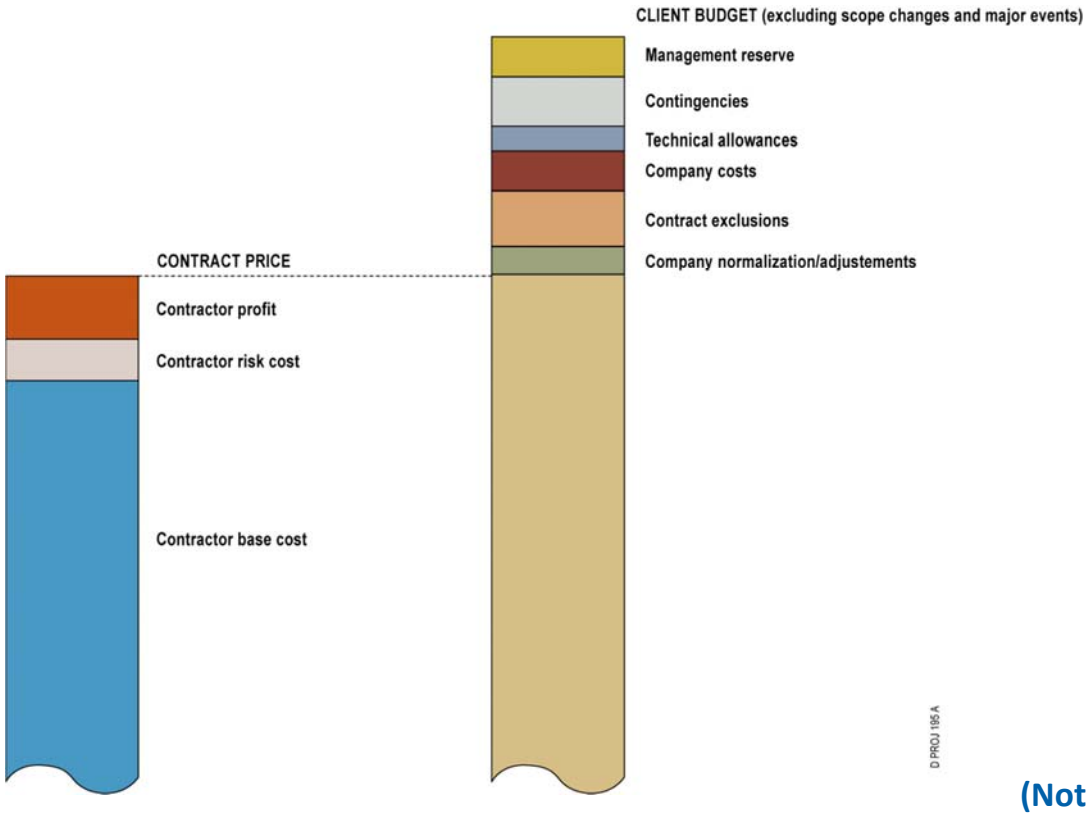
Probabilistic approach

- **No cost estimate is 100% certain**
- **A comprehensive risk analysis can be performed to evaluate the probable costs of a Project and their probability of occurrence**
- **Based on these results, the necessary contingencies will be calculated**
- **In the absence of a detailed study, statistical ratios (based on past experience such as those given hereby) giving the percentage of base cost to be added on top of the estimate can be used to calculate the necessary contingencies**

Statistical approach

Type of Facilities	Class 5	Class 4	Class 3
Onshore pipeline	20	15	10
Offshore pipeline	20	15	10
Onshore facilities	25	20	15
Offshore facilities	25	20	15
Deep offshore facilities	25	20	15
Subsea development	25	20	15
Onshore modifications		30	20
Offshore modifications		35	20

Contract prices and client budget



(Not to scale)

Cost management

- About cost management
- Planning cost management
- Estimating costs
- Determining budget
- Controlling costs

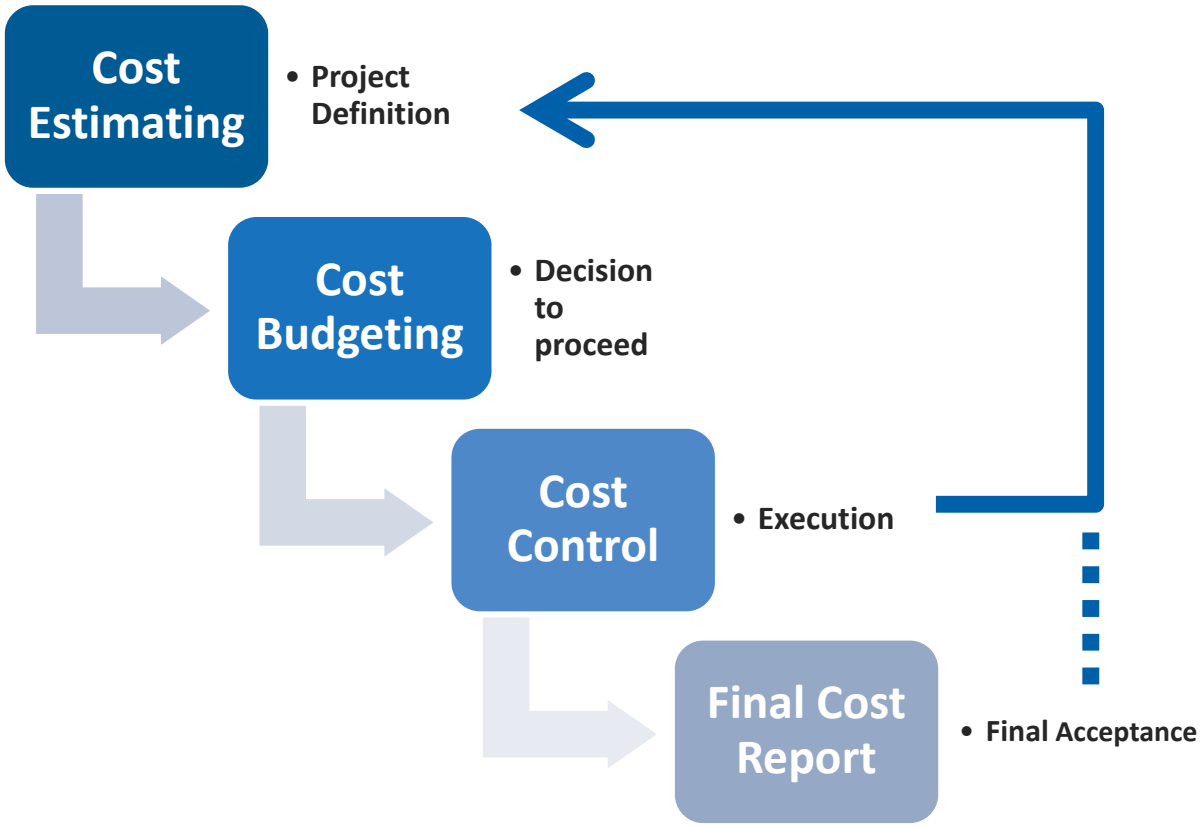
Major cost control objectives

- To monitor and control all Project costs in order to accurately and continuously evaluate the anticipated final cost of the Project thus enabling Project Management to take any necessary preventive and /or corrective actions
- Cost controllers coordinate the activities of the project team in order to maintain project expenses within the budget limits
- To provide feedback for future estimates

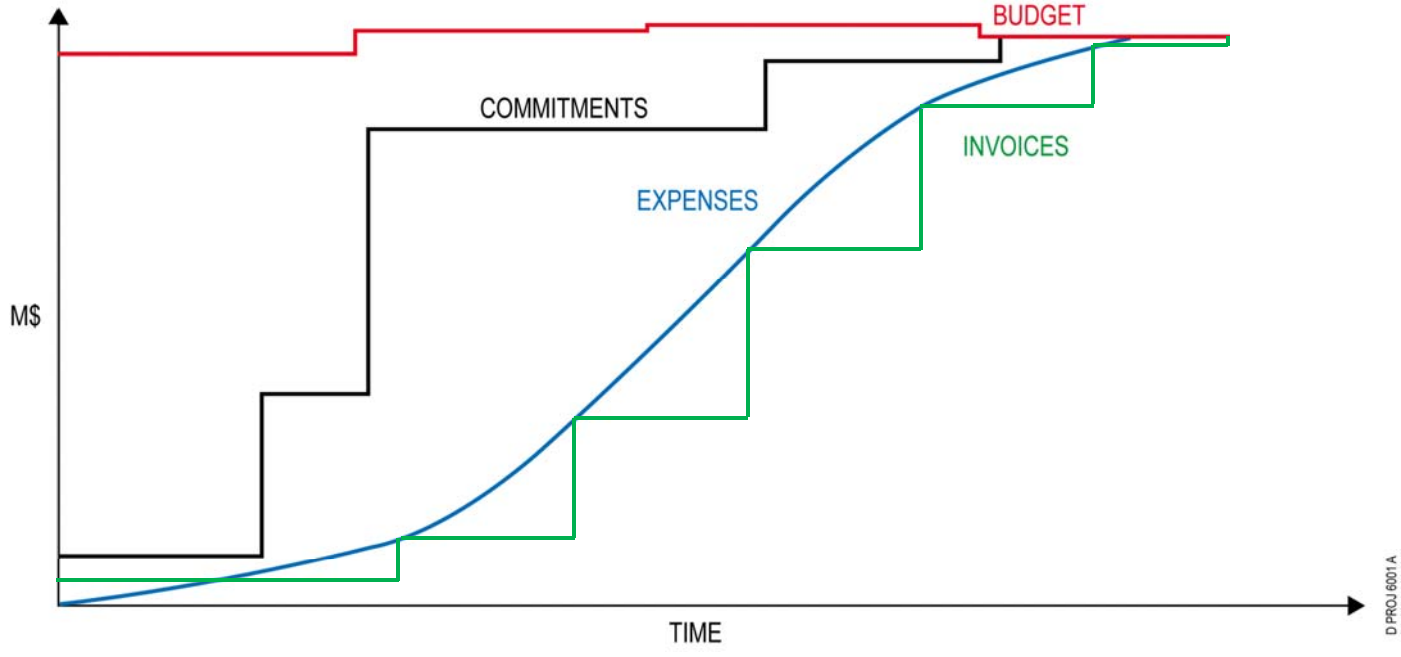
Major cost control tasks

- To detect adverse cost trends, early enough to allow corrective action to be taken.
- To anticipate project cost changes by preparing a reliable forecast
- Manage change orders (Contractor to issue change orders and Company to discuss and accept)
- Control financial and cash flows status, trends and currency balances.
- Cost Control activities start at Project start and finish far after hand-over to Operations, when construction contracts are closed out (with claims settled) and final Cost Control report issued.

Cost Management Processes
as of Project Execution Point of View



Cost control curves



Forecasting final cost

- **An Estimated Final Cost for a each commitment is a forecast of related costs based on its intrinsic performance. The most common forecasting techniques are**
  - EFC = Actuals to date + Remaining part to be realised
    This approach is most often used when current variances are seen as not typical and the project management team's expectation is that similar variances will not occur in the future
  - EFC = Actuals to date + Remaining part to be realised x Performance factor
    This approach is most often used when current variances are seen as typical of future variances
  - EFC = Actuals to date + New estimate for the works
    This approach is most often used when past performance shows that the original estimating assumptions were fundamentally flawed, or that they are no longer relevant due to a change in conditions
- **At the end of the Project, the final cost analysis will establish the Final cost, after hand-over, when construction contracts are closed out (with claims settled) and the final Cost Control report is issued**
- **Each of the above approaches may be discussed for each given commitment**

Contingency Management

- **Contingency amount shall be clearly identified in the Project budget**
  - For projects already sanctioned with an Approved Budget prior to launching call for tenders and contracts awards, the contingencies are based on the costs estimates (P50 – Most Likely amount).
  - For 'complex'/'risky' projects sanctioned with an Approved Budget after Basic engineering and call for tender stage, the contingencies are evaluated by the Project team already in place.
- **In any case, the exclusions mentioned for the contingencies still remain**
- **During the execution of a project the contingencies management consists in keeping up-to-date the utilization of the contingencies but also re-estimating these contingencies when project milestones are reached**
- **Contingencies can only be used with the agreement of the Management and in line with the Management Agreement and the Financial Agreements**

Company cost report format principles

	(1) Approved Budget	(2) Scope Change	(3) Budget Transfer	(4) Current Budget (1+2+3)	(5) Commit.	(6) Estimate to Complete	(7) Estimated Final Cost (5+6)	(8) Variance (4-7)	(9) Expend. Incurred	(10) Approved Invoices
WP 1	100	0	0	100	90	12	102	2	70	65
WP 2	50	0	10	60	60	0	60	0	60	60
WP 3	90	0	-10	80	70	5	75	-5	68	65
Sub-total	240	0	0	240	220	17	237	-3	198	190
Contingencies	24	0	0	24	-	22	22	-2	-	-
Total	264	0	0	264	220	39	259	-5	198	190

Cost monitoring process by Company

- **Company cost control process and own involvement in tracking of cost components depends on the type of contract(s) placed for project execution.**
  - If a contract is on reimbursable basis, Company will have access to all cost elements and Company will basically be responsible for the complete Project cost.
  - If a contract is on a Lump Sum basis, Company will have access only to the cost items specified in the contract (Global prices for work-packages, unit prices for changes…).
- **For all cases, Company will have access to the cost estimate to support any change order, will be able to check it, approve it, and it will then be included in the cost control process.**

Project cost variations possible causes

- **Causes due to the operator/Company**
  - Project definition ambiguous and/or incomplete
  - Change during the Project execution (basic design data, scope, interfaces with other projects or other facilities…)
  - Delayed access to construction areas
- **Causes due to the Company or Contractor estimates**
  - Insufficient provisions
  - Missing costs
  - Wrong assumptions on market costs
- **Causes due to project development/management**
  - Contractual strategy ambiguity, unclear interfaces between contractor(s)
  - Endorsement of FEED leading to changes
  - Conflicts with contractor(s)
  - Insufficient quality of Project Management Team; of Project organization
  - Delays in achieving Company tasks

Summary



- **Different methodologies are used to estimate project costs at different stages its progress**
- **The level of contingencies to be added at each stage depends on the data available to perform the estimate**
- **A Basis of Estimate (BOE) should be produced to indicate the input data used and the assumptions made**
- **The level of contingencies will decrease as the project proceeds but should not be reduced too drastically too early as unforeseen additional costs often appear in the last part of the project**
- **Budgets may include a management reserve to cater for unlikely events which are not part of the contingencies**
- **Several methods exist to forecast the project final cost**



Time

Time management

Foreword

- **Main objective**
  - Finish the project on time

- **Main tools and means**
  - Planning activities
  - Project schedule
  - Critical path identification
  - Progress control

Time management

- About project controls, planning and scheduling
- Planning schedule management
- Defining activities
- Sequencing activities
- Estimating activity durations
- Estimating activity resources
- Developing schedule
- Controlling schedule

What does it take to plan a project?

- Objective → Contract & Scope of Work definition
- Schedule → Target completion date
- Strategy → Execution plan
- Budget → Baseline for progress control (cost & time, focus on time)
- Forecast → Periodic projection
- Organization → Planning engineer

Time management

- About project controls, planning and scheduling
- **Planning schedule management**
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- Controlling schedule

Planning interaction in project control

- **Estimation (proposal phase)**
  - During proposal, quantities are not known, they are estimated. Quantities are necessary for durations
  - Some resources have daily rates (such as installation vessels), duration of use allows Estimation to estimate associated costs
- **Cost engineering & control (contract phase)**
  - A Cost Engineer is not performing accounting, he needs to forecast costs, then schedule update are necessary
  - Cost provide spent manhours, which allow to validate schedule trends with productivity
- **Contract management (proposal & contract phases)**
  Planning is based on Contract
  - Changes in schedule could have contractual impact → Contract Manager to be informed
  - Changes in the Contract (change order, delays on input data from Client…) could have impact on Schedule
  - EOT to be managed jointly…
- **Risk management (proposal & contract phases):**
  - Risk models are linked to (or simplified) schedule → planning provides input and received recommendations for improvement in return

Planning interaction with all other stakeholders

- **Project management**
  - Bring good and bad news as it occurs and avoid the « shoot the messenger syndrome »
- **Home office Engineering Procurement & Subcontracting disciplines**
  - Purchase equipment and place subcontracts based on preliminary data
  - Deliver scope of work at the required level of quality, within budget and time
- **Manufacturing & transportation**
  - Economy of scale versus Required-On-Site (ROS) dates
  - Integration of vendor data by engineering
- **Yard fabrication & Construction management**
  - Tight schedule requires trades to work in parallel and requires close monitoring
- **(Pre-)commissioning, hand-over & start-up teams**
  - Appreciate impact of activities and transfer of responsibility to construction productivity

Understanding of these processes & interactions starts with the breakdown into manageable work packages, both by area and by disciplines

Time management

- About project controls, planning and scheduling
- Planning schedule management
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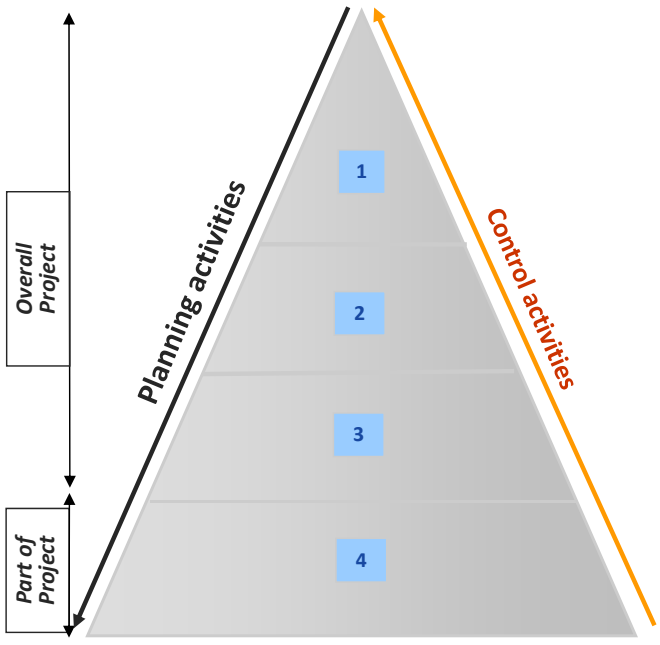
Planning and scheduling

Basic techniques

- **What is the difference between planning & scheduling?**
  - Planning: Elaborating the Plan (strategy)
  - Scheduling: Elaborating the sequencing of activities (with dates)
- **Some planning techniques**
  - PDM (Precedence Diagramming Method)
  - PERT (Program Evaluation & Review Technique)
- **Some techniques of analysis**
  - CPM (Critical Path Method) → Total duration & float oriented
  - CCM (Critical Chain Method) → Resource limit oriented
  - Resource levelling
  - What-if scenarios (Monte-Carlo)
- **Schedule presentation**
  - Activity list
  - Bar Chart
  - Network Diagram

Work Breakdown Structure

Components' hierarchy

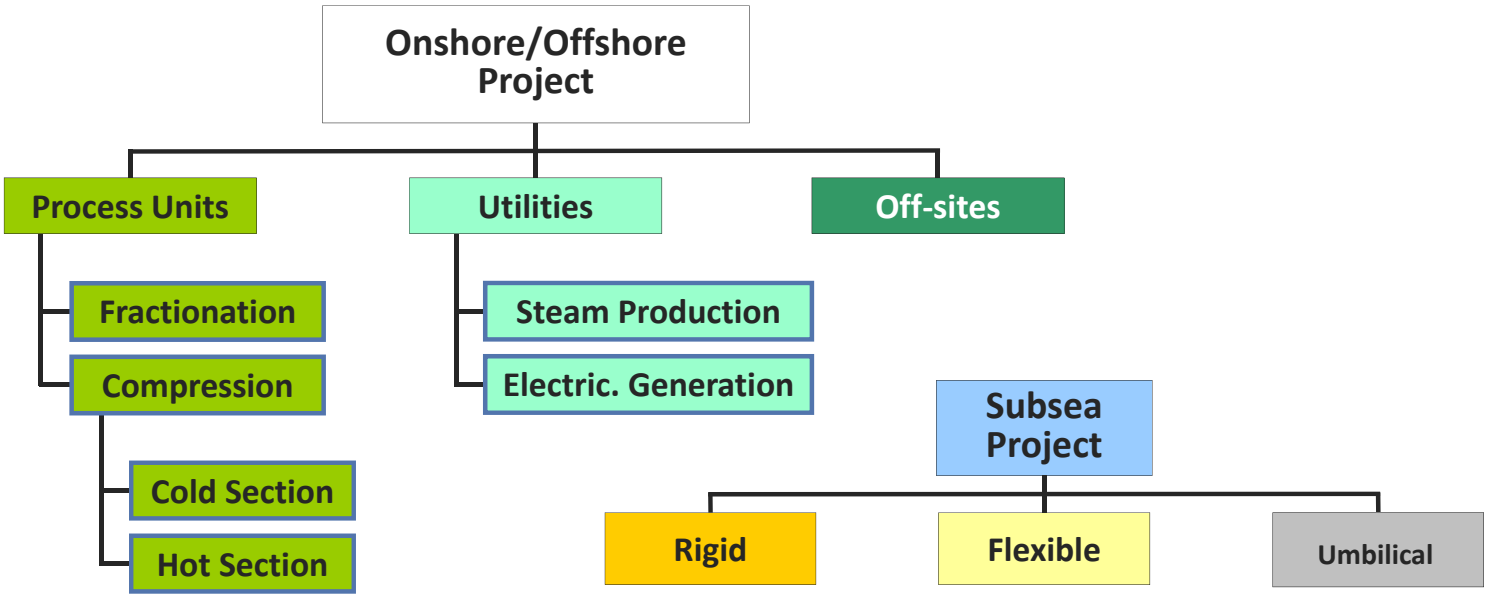


- **The WBS is generally built with a top-down approach**
- **Information is rolled up with a bottom-top approach to produce an overall picture of the project**

Work Breakdown Structure

WBS (Work Breakdown Structure)

- Represents "what is to be done"
- Reflects the geographical and/or process split of work (Area, Unit, Platform, Function, etc.)



Time management

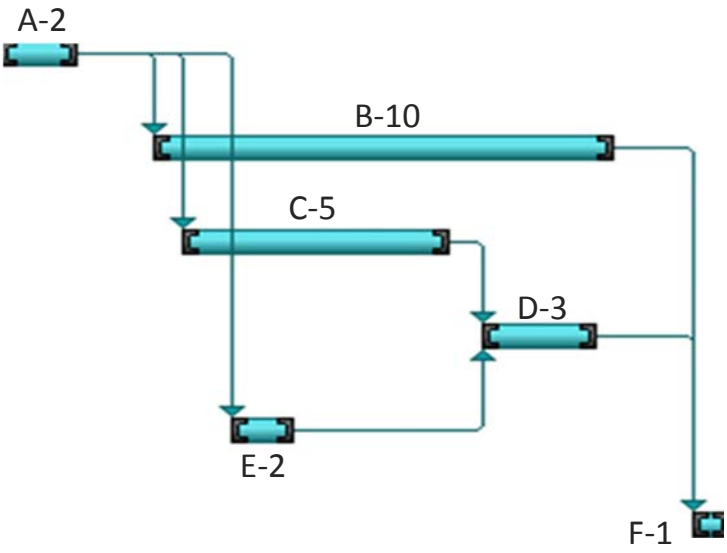
- About project controls, planning and scheduling
- Planning schedule management
- Defining activities
- **Sequencing activities**
- Estimating activity durations
- Estimating activity resources
- Developing schedule
- Controlling schedule

Schedule preparation

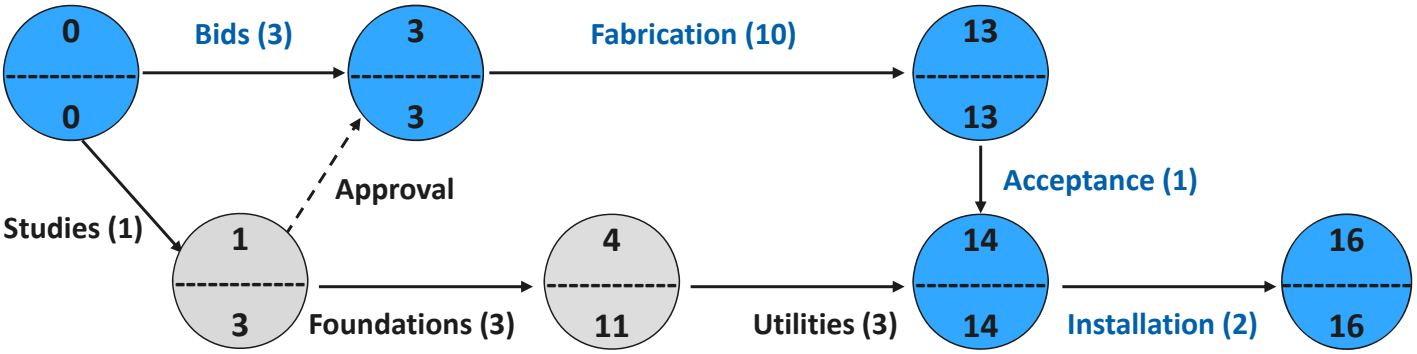
- **Scheduling is one of the fundamental tasks of Project Management**
- **The most common way to prepare the first schedule study of a project is through a Bar Chart**

PROS: easy to prepare, easy to be read and understood, possibility to condense several tasks in a single line

CONS: does not allow controlling the logics of a complex sequence of tasks; nor controlling schedule upon changes in tasks' durations



Schedule preparation



- **A network built using the Project Evaluation and Review Technique (also called Critical Path Method) is in fact the only way to have sequencing logics built into the schedule**
- **Bar Charts can be then deduced from the network**

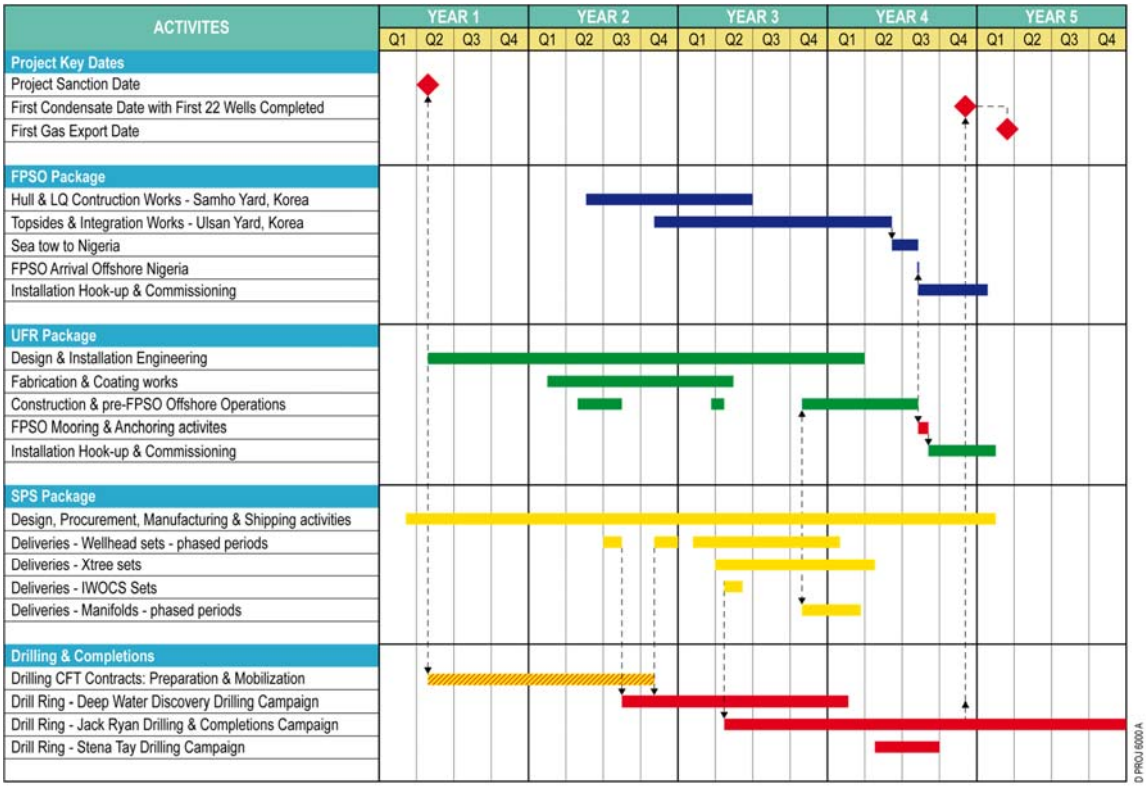
Scheduling and Progress Control of a Project

- **The resulting Schedule shall enable proper Scheduling and Progress Control of the Project**
- **In other words, it shall provide at all times Project Management with a clear picture of progress against the Project baseline schedule**
  - Did activities start at the initially planned date?
  - Ongoing activities will be completed at their initially planned completion date?
  - Will it be possible to start the following activities as planned?
  - Ultimately, will the Project be completed at the expected date?
- **The answer to these questions shall enable the timely identification of adverse trends and shall therefore enable Project Management to make corrective actions and, should it be necessary, recovery plans**

Schedule levels

- **Level 0 – Project Master Schedule**
  - One-page executive summary schedule used for reporting at Project Management level
  - Frozen at Project Sanction and constitutes the Initial Baseline Schedule
  - Features target dates, key milestones and main phases
- **Level 1 – Integrated Project Control Schedule**
  - Time-scale logic diagram featuring decision phases, contracts sequence, work package summary activities including Long Lead Items and major milestones
  - Displays the overall project critical path
- **Level 2 – Contractor Schedules**
  - These networks cover all the activities/tasks of the Contracts
  - All the milestones necessary to control contractors' physical progress shall be identified in these schedules
  - Procurement of main equipment and fabrication, construction, installation, commissioning shall be shown separately, with a clear highlight of the critical path

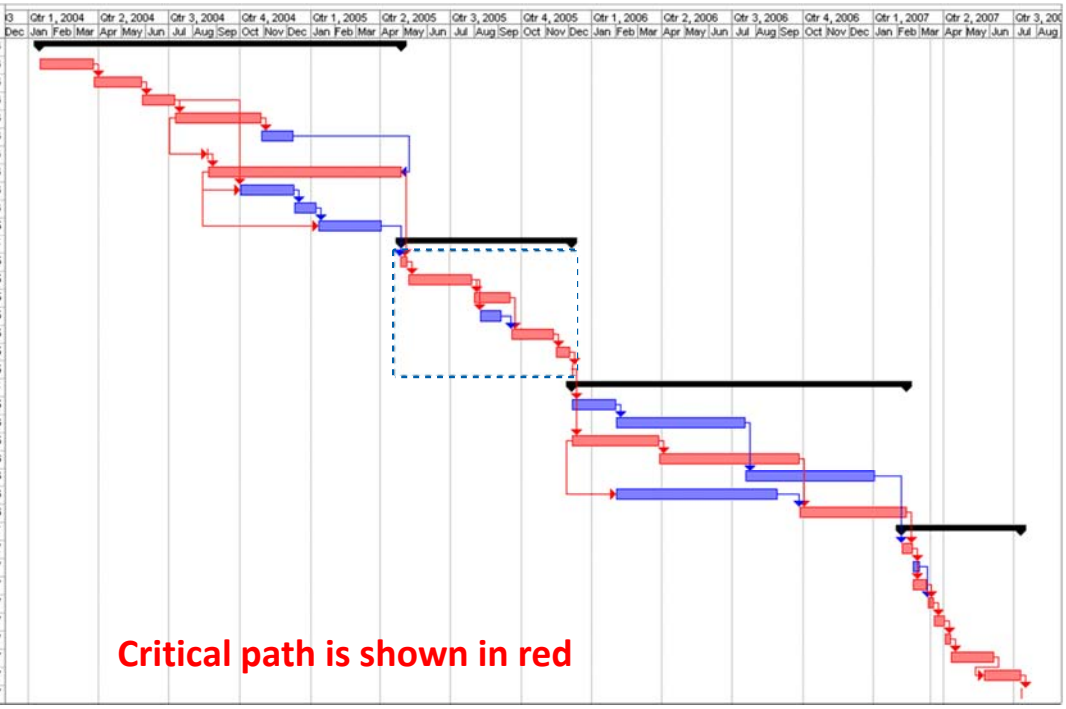
Level 0 schedule



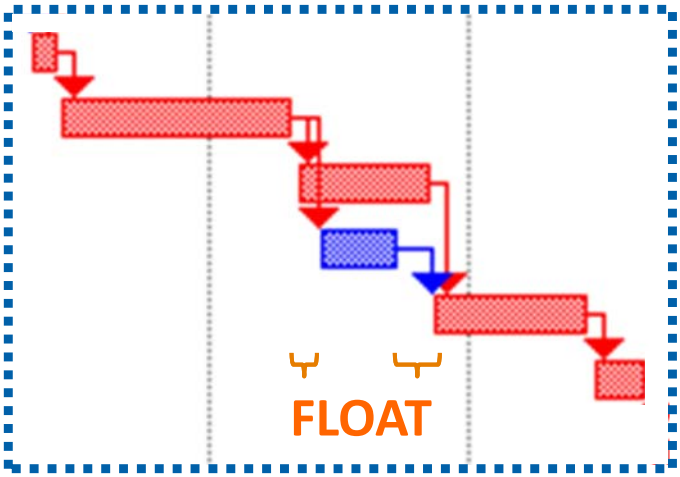
Level 1 schedule

Example: Offshore platform

ID	Task Name	Duration	Start
1	**Preliminary Tasks**	**336 days**	**Thu 15/01/04**
2	Feasibility study	50 days	Thu 15/01/04
3	Conceptual study	45 days	Thu 25/03/04
4	Pre-Project	30 days	Thu 27/05/04
5	Site survey	80 days	Thu 08/07/04
6	Survey report	30 days	Thu 28/10/04
7	**Decision to proceed**	1 day	**Thu 19/08/04**
8	Basic engineering	180 days	Fri 20/08/04
9	Contractors Pre-Qualificati	50 days	Fri 01/10/04
10	List of Contractors	21 days	Fri 10/12/04
11	Preparation ITB	60 days	Mon 10/01/05
12	**EPSC Selection**	**157 days**	**Fri 29/04/05**
13	Issue ITB	6 days	Fri 29/04/05
14	Bids Reception	60 days	Mon 09/05/05
15	Technical analysis	35 days	Mon 01/08/05
16	Commercial analysis	20 days	Tue 09/08/05
17	EPSC Negotiation	40 days	Mon 19/09/05
18	Recommendation	15 days	Mon 14/11/05
19	Contract Approval	1 day	Mon 05/12/05
20	**EPSC Performance**	**310 days**	**Tue 06/12/05**
21	Detail Engineering Jacket	40 days	Tue 06/12/05
22	Steel supply Jacket	120 days	Tue 31/01/06
23	Detail Engineering Deck	80 days	Tue 06/12/05
24	Steel supply Deck	130 days	Tue 28/03/06
25	Jacket Fabrication	120 days	Tue 18/07/06
26	Equipment Delivery	150 days	Tue 31/01/06
27	Deck Fabrication	100 days	Tue 26/09/06
28	**OffSHORE OPERATIONS**	**111 days**	**Tue 06/02/07**
29	Barge mobilisation	10 days	Tue 06/02/07
30	Jacket loading	8 days	Tue 20/02/07
31	Deck loading	14 days	Tue 20/02/07
32	Transport J/D to site	6 days	Mon 12/03/07
33	Jacket Installation & Piling	10 days	Tue 20/03/07
34	Deck Installation	6 days	Tue 03/04/07
35	Hook-up work	40 days	Wed 11/04/07
36	Commissioning	35 days	Wed 23/05/07
37	**Ready for Start-up**	1 day	Wed 11/07/07



Links between activities and critical path



- ***Reminder:*** **links between two consecutive activities can be:**
  - Finish to Start
  - Start to Start
  - Start to Finish (uncommon)
  - Finish to Finish

- **Planning two or more sets of activities of different durations in parallel may create float on these particular activities**
- **The critical path is the path of activities with no float and provides the shortest project duration**

Contractor scheduling process

- **Scheduling by EPC Contractors is done at a more detailed level than by Company**
  - A detailed WBS/OBS is prepared, to define areas and work phases for the project schedule & progress reporting
- **Scheduling hierarchy generally includes 4 Levels for the relevant EPC contract:**
  - Level 0 – Project Master Schedule: executive summary
  - Level 1 – Overall Project Schedule: rolled-over from Level 2
  - Level 2 – Areas Schedule: contract control schedule, prepared as a CPM network
  - Level 3 – Detailed Schedules:
    - Engineering deliverables (usually integrated with the engineering progress measurement system)
    - Procurement purchasing status and material status reports
    - Site construction schedule, prepared at site, in line with the Level 2 schedule, the global schedule and construction contractors detailed schedule

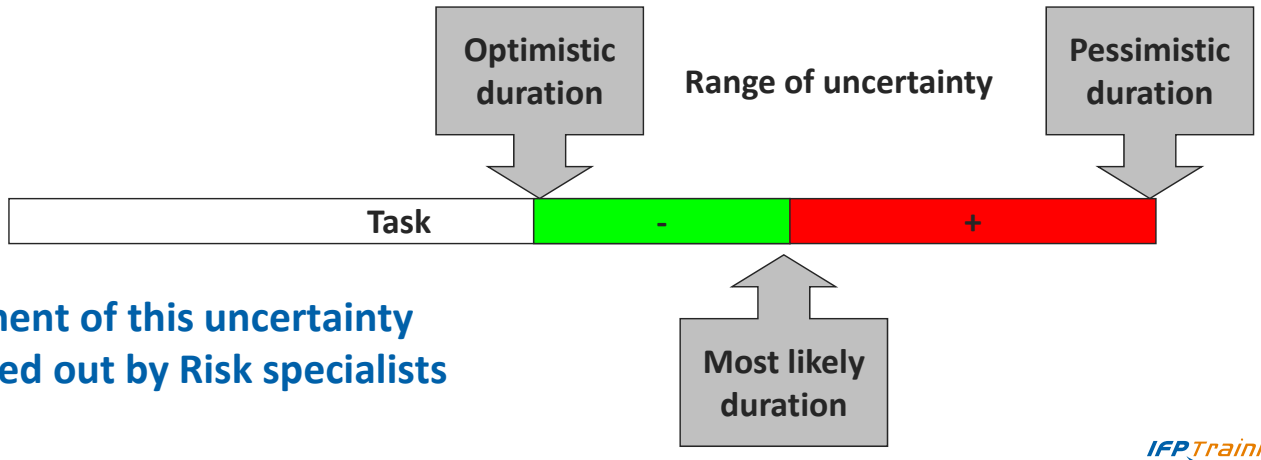
Note: These levels may be called differently by from one contractor to another (e.g 1 to 4)

Time management

- About project controls, planning and scheduling
- Planning schedule management
- Defining activities
- Sequencing activities
- **Estimating activity durations**
- Estimating activity resources
- Developing schedule
- Controlling schedule

Three point estimating of activities' duration

- **Most likely duration**: estimate based on duration of the activity given the resources likely to be assigned, expected productivity, realistic expectations of availability for the work, dependencies on other participants and interruptions.
- **Optimistic duration**: best case scenario
- **Pessimistic duration**: worst case scenario

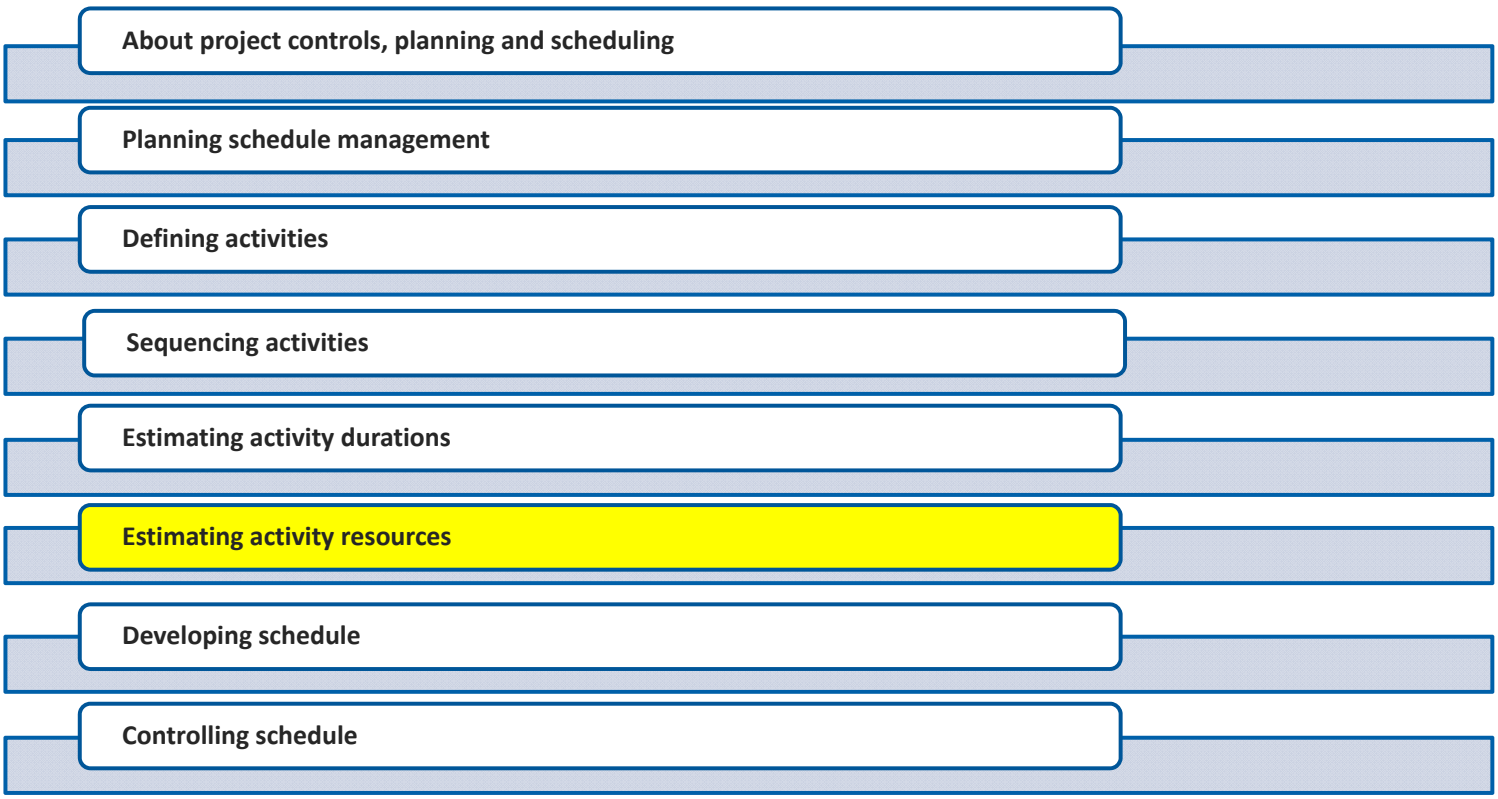


Treatment of this uncertainty is carried out by Risk specialists

Schedule contingency reserves

- Duration estimates may include contingency reserves sometimes called time reserves or buffers
- Allocated for identified risks that are accepted and for which contingent or mitigation responses are developed – (know unknowns)
- Can be defined as a percentage of the estimated duration or using Monte-Carlo techniques
- Can be aggregated into buffers and identified as such in the schedule
- As the project proceeds the time buffer can be used, reduced or eliminated
- Should be controlled by project management

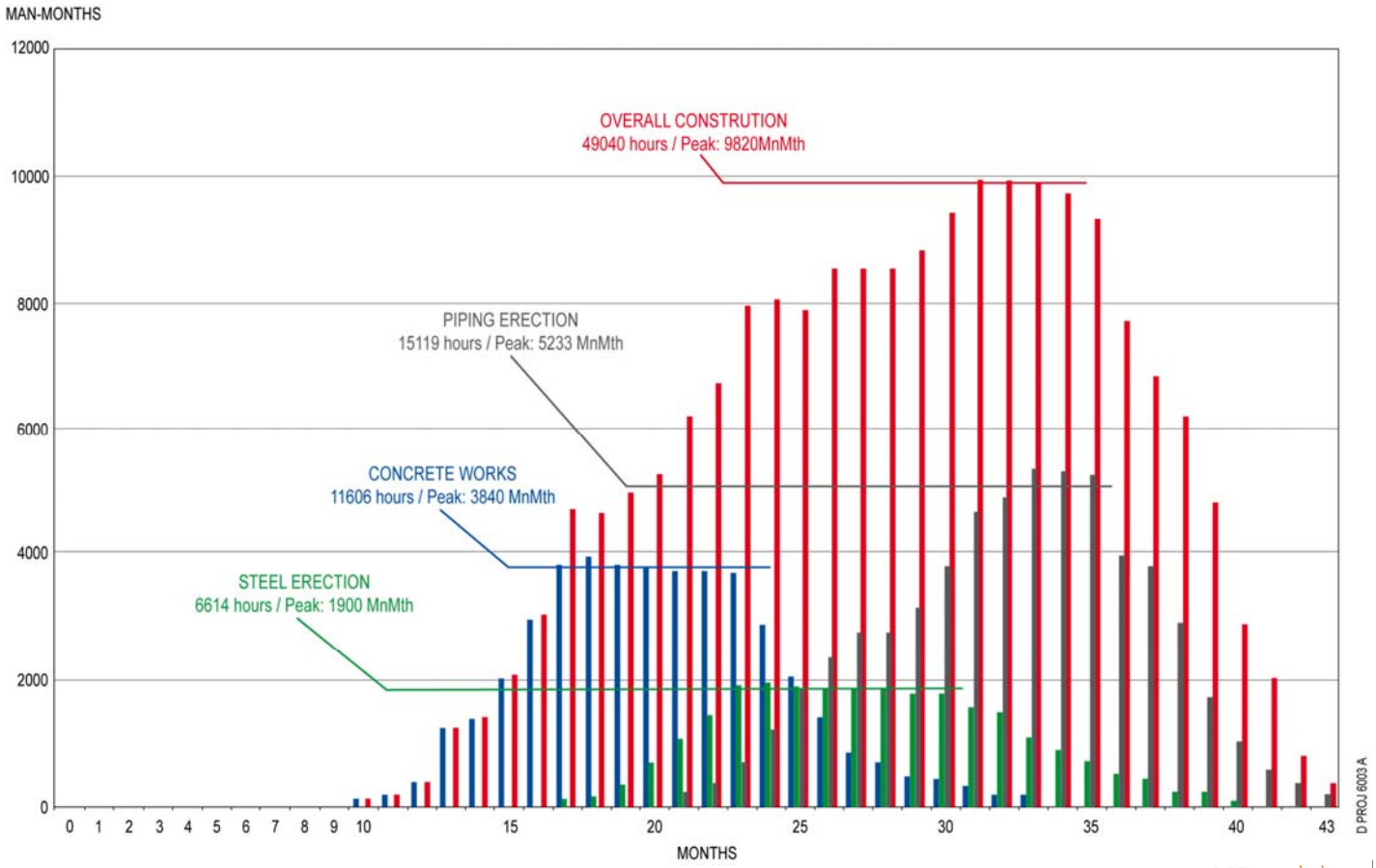
Time management



Activity resources

- **Activities might require all or part of the following**
  - Material resources
  - Human resources
  - Equipment
  - Supplies
- **For each of these**
  - Type and quantities shall be estimated as a function of time
  - Histograms should be produced
  - Availability shall be checked
  - Compatibility between mobilization peaks and maximum mobilization limits shall be verified
- **After such a study**
  - Some activity durations might require being revised
  - Rescheduling might be necessary

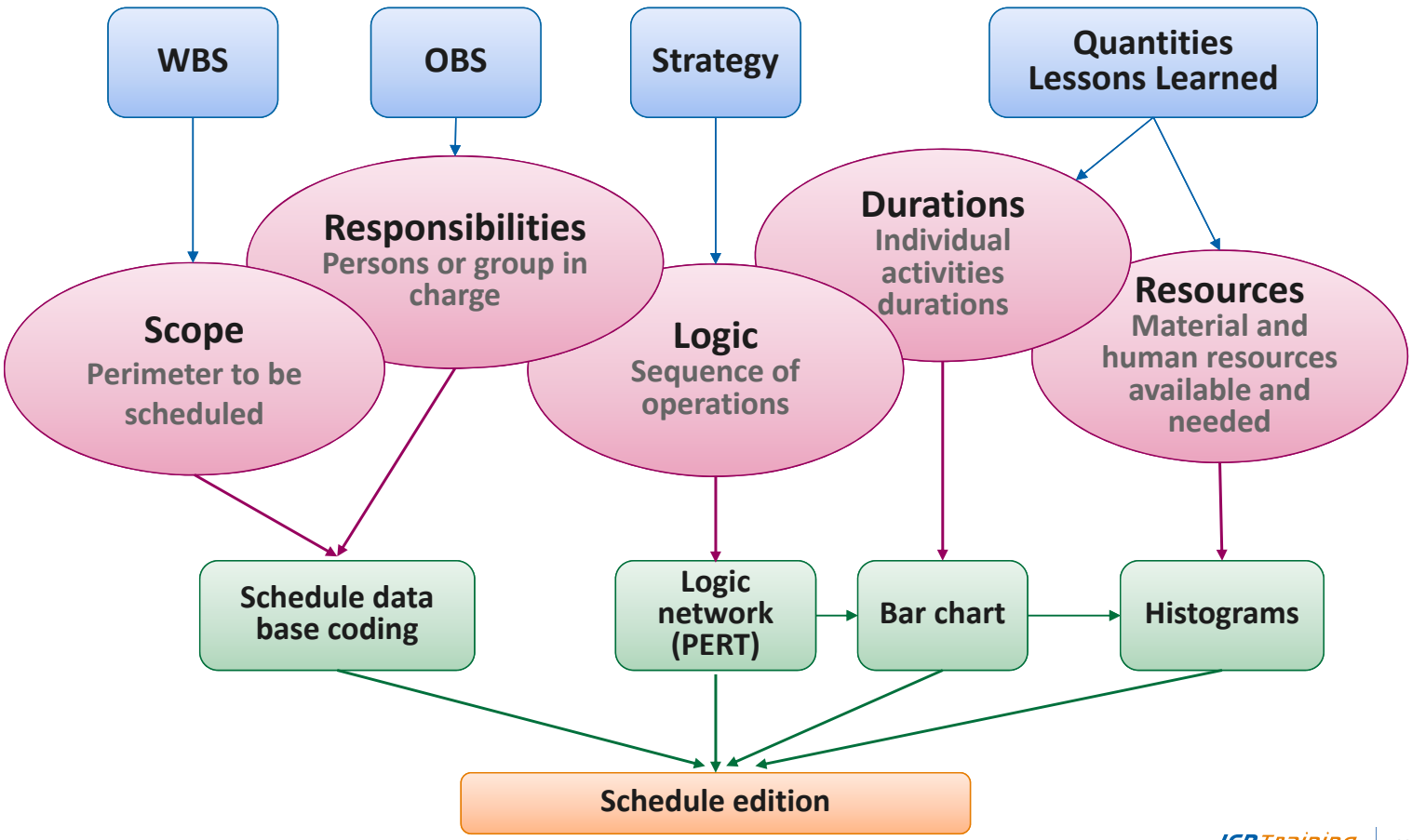
Example of histogram of necessary resources



Time management

- About project controls, planning and scheduling
- Planning schedule management
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- Estimating activity resources
- **Developing schedule**
- Controlling schedule

Estimate resources and duration



Typical critical path

- **As a result of the schedule preparation process, the critical path for an onshore project usually goes through:**
  - Procurement of Long Lead Items
  - Piping erection related to these LLIs
  - Relevant controls and instrumentation completion and loop tests
- **And/or through:**
  - AFC Process PIDs
  - Main equipment purchase (Vendors drawings)
  - Engineering to 40% isometric drawings
  - Piping pre-fabrication
  - Piping erection
  - Instruments loop checks

Anticipating project duration

General considerations

- **Long Lead Items (if any)**
  - What LLIs will be on the the project critical path?
  - How will they govern the schedule (in terms of delays, risks)?
- **Global project size and main phases: Engineering, Procurement and Construction**
  - What resources they require?
  - Will these resources be available at the right location and at the right time?
  - How many man-hours will be required at the mobilization peak?
  - As a consequence, what is feasible progress rate?
- **Permitting activities**

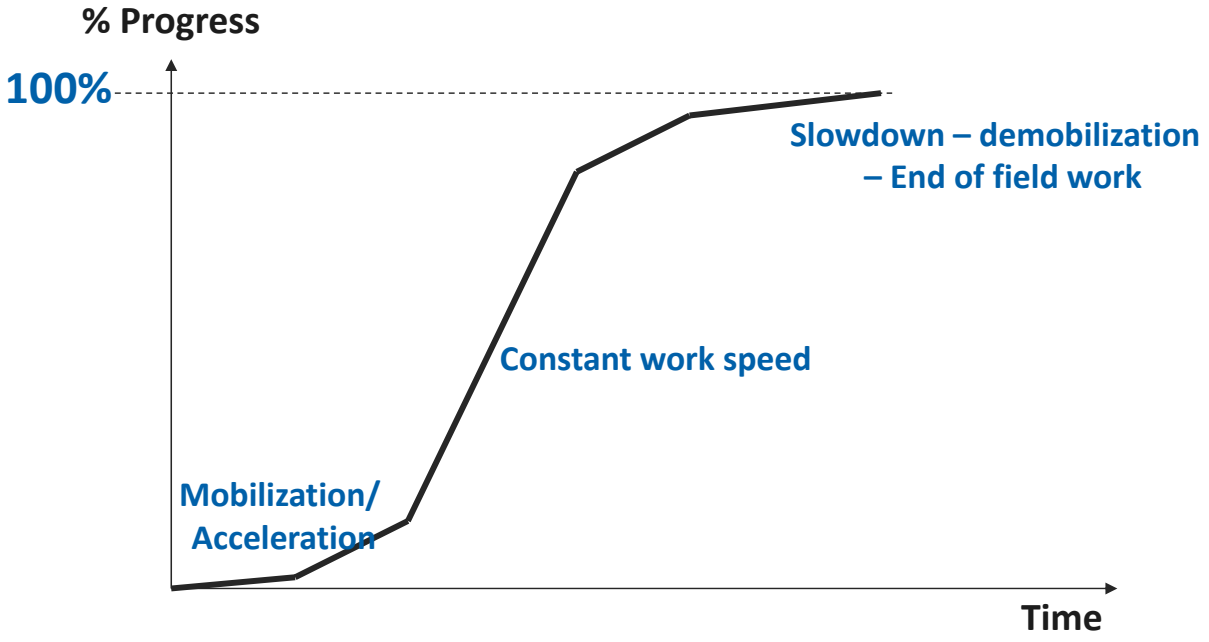
Anticipating project duration

Expected progress for each phase

- **Standard statistic progress curves are available to provide a reference progress for each activity**
- **Achievability of such progress curves shall be appraised for:**
  - Engineering
    - For each discipline (process, equipment, civil, piping, electrical, instrumentation…)
  - Procurement
    - For equipment and bulk material Purchase Orders
  - Construction
    - For each trade (Civil, U/G piping, Piping pre-fabrication, equipment erection, piping erection, electrical, instrumentation, painting, insulation, etc.)
- **Do the resulting progress curves (for the whole Project or for each unit) comply with the intermediate and final Contractual milestones?**

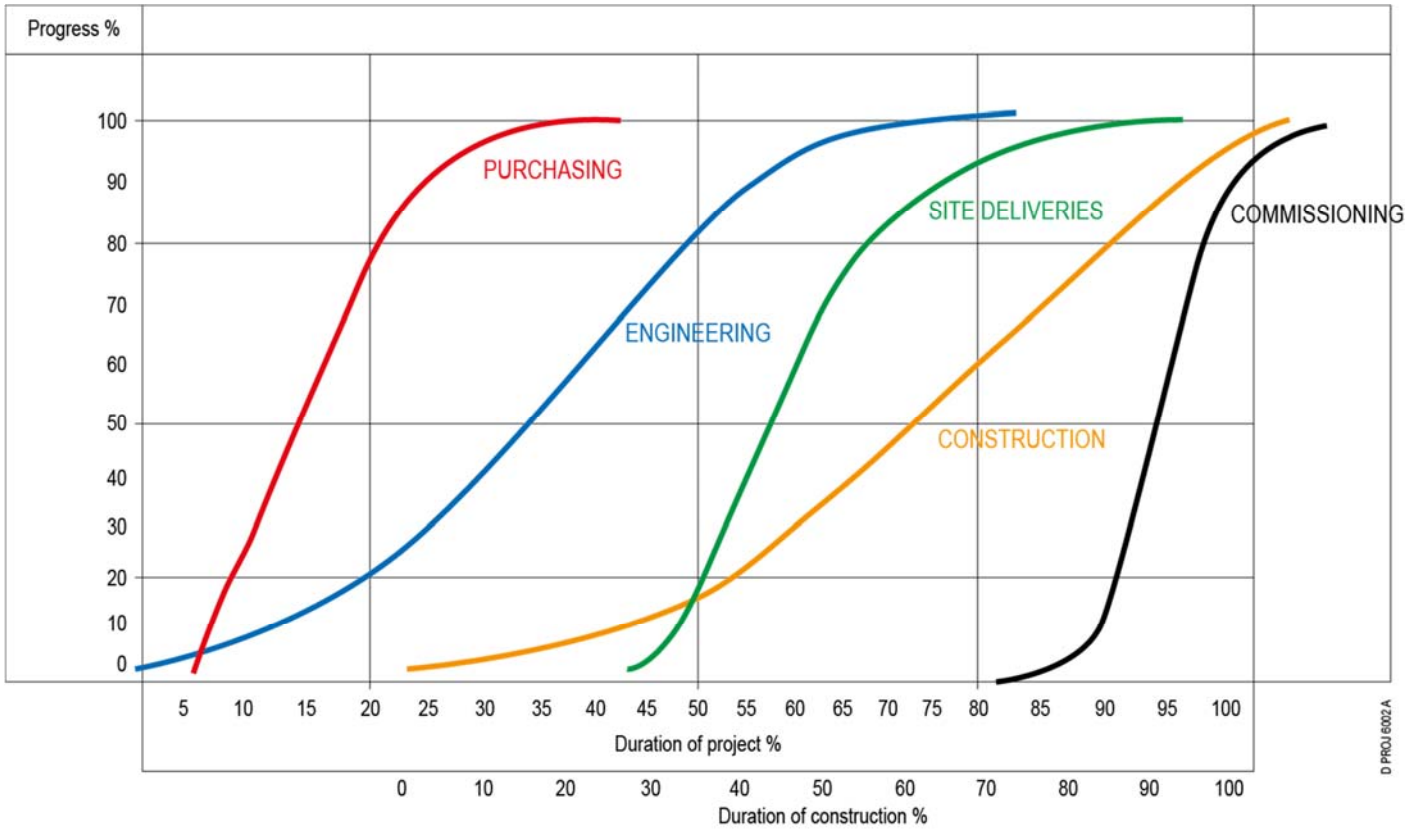
Anticipating project duration

Typical S-shaped progress curve



Anticipating project duration

Typical progress curves and milestones



Optimal logical sequences for construction activities

- **For each area:**
  - AFC plot plans and P&IDs are required to launch construction
  - Start of piping pre-fabrication requires ≈40% of AFC isometrics and 50-60% of piping materials of all required types (CS, SS, Cu-Ni, GRE...) and enough elbow, fittings, etc.
  - Structures have to be fabricated and delivered
  - Start of piping erection requires ≈50% of equipment nozzles available and all steel structures
- **Construction activities shall be sequenced in order to provide work front at site**
  - Structural steel shall be a priority for procurement priority, so that construction of interconnecting pipe racks starts quickly allowing an early the mechanical contractor mobilization
- **Each type of unit (power, fire water, utilities and process…) should be completed progressively so that pre-com/com activities (that are carried out per unit) are performed in the most time-efficient fashion**

Schedule compression

Techniques that can be used to shorten the schedule duration without reducing the project scope, altering safety or quality:

- **Crashing**
  - Adding additional resources, approving overtime work, paying to expedite delivery
  - Used only for activities on the critical path
  - May result in additional costs and risks
- **Fast tracking**
  - Perform activities in parallel instead of sequentially
  - Feasibility of parallel activities to be checked
  - May result in rework and increased risks or costs

Points to be checked to ensure the integrity of the Schedule

- **No lags:**
  - their status cannot be checked during schedule updates
  - to be replaced by an activity
- **No open ends:**
  - no activity without a predecessor (except Project Start)
  - no activity without a successor (except Project Finish)
- **No fixed constraints**
- **Was Resource levelling done?**
- **Critical paths**
- **Compliance with Contract Milestones, intermediate CD**
- **Floats**
- **Number of critical activities should be between 10 and 15%**

Scheduling software

- **Typical software used by Planning engineers:**
  - Microsoft Project for small EPC projects with little complexity
  - Primavera Project Management for large EPC projects
    - It can manage a greater amount of tasks and
    - It allows multiple users to feed the database

- **Typical tools for presentation purposes:**
  - Level 0 schedules are often made with Excel based upon information taken from the Primavera Level 1 rolled-up to Level 0
  - Progress curves and tabular reports are often prepared with MS Excel

Time management

- About project controls, planning and scheduling
- Planning schedule management
- Defining activities
- Sequencing activities
- Estimating activity durations
- Estimating activity resources
- Developing schedule
- **Controlling schedule**

Schedule analysis

Work process in 3 steps

- **Establish a Reference = Baseline**
  - 1st issue = Planned *(Thermometer fabrication & calibration)*



- **Check progress status**
  - Actual and Trend *(Thermometer measurement)*
  - Detection of delays

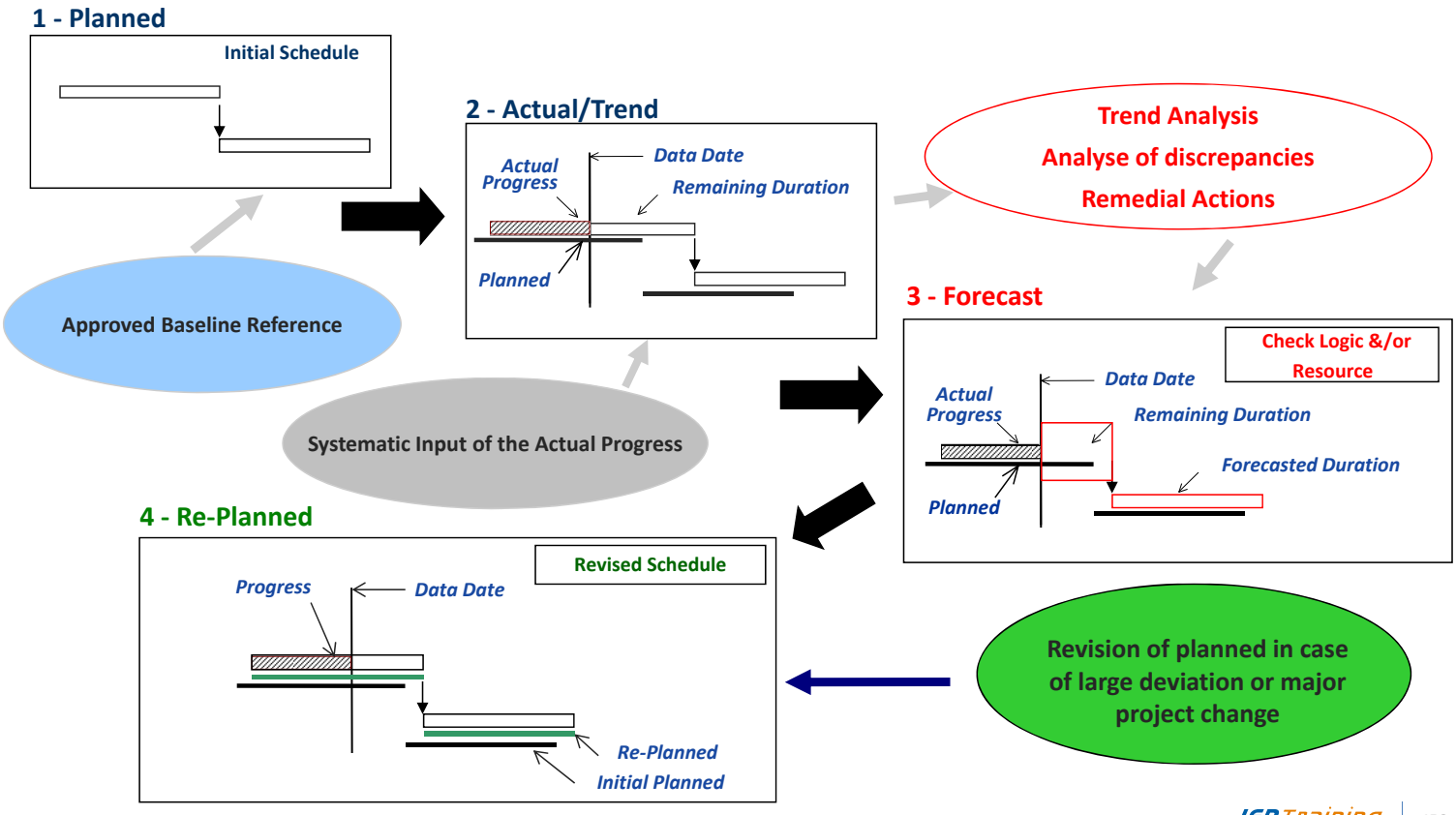


- **Enforce corrective actions, if needed**
  - Forecast *(Take Aspirin)*
  - Re-Plan/Recovery Plan *(Thermometer re-calibration)*
  - Terminology: Re-Plan (Previous Planned becomes « Initial »): Revision of the schedule





Schedule analysis



Progress control

- **The progress control system allows to compute, at cut-off dates in accordance with the Project Calendar, the planned progress and the actual progress in order to**
  - Compare on a regular basis the quantity of work done versus the quantity of work planned
  - Assess if objectives for completion dates can be met
  - Analyze trends and take corrective actions if necessary

- **Productivity measurement is the measure of the efficiency in the utilization of resources**
  - A factor smaller than 1 demonstrates a bad productivity
  - A factor higher than 1 demonstrates a good productivity

Physical progress measurement

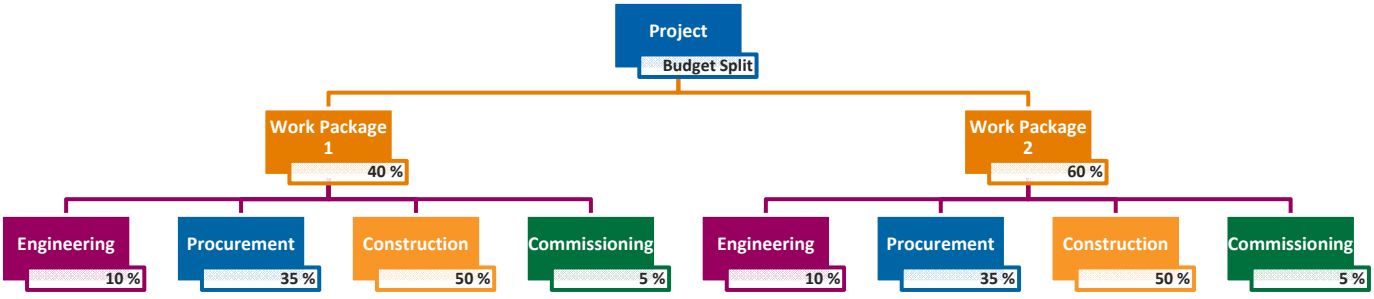
An example

- **A Factory has to fabricate 100 identical items (the Work), in a 10 days period, cost expected is 1000 Euros per item**
- **After 5 days, 10 items are fabricated, and cost incurred is 800 Euros (= expenses for fabrication of each of those 10 items)**
- **Progress in Time-Schedule is:**
  - 5 days spent → 5/10 = 50%
  - 10 days expected
- **Productivity is:**
  - 800 Euros spent (Actual value) → 1000/800 = 1,25 > 1 GOOD
  - 1000 Euros expected (Earned value)
- **But Physical Progress is:**
  - 10 items fabricated → 10/100 = 10%
  - 100 items to be fabricated

Progress measurement principles

- **Project activities are split according to structure close to the WBS/OBS**
- **Weights are assigned using convenient units (USD, manhours…) in order to split all project tasks into elementary tasks**
- **For each Project work package or sub-project to be independently controlled, these tasks are aggregated by levels:**
  - Work-Package or sub-project
  - Categories: home office services, engineering, procurement, construction…
  - Sub-categories: engineering disciplines, requisition, construction trade...
  - Tasks: engineering deliverables, equipment, construction individual items
  - Elementary steps («scales»): drawing preparation step, procurement fabrication step, construction work step
- **During project execution, progress achieved is measured for all elementary steps and aggregate to the different levels**

Exercise: Overall progress measurement



EPCC progresses for WP1

E: P: C: Comm:

EPCC weighted progresses for WP1

E: P C: Comm:

Progress for WP1:

Weighted progress for WP1:

EPCC progresses for WP2

E: P: C: Comm:

EPCC weighted progresses for WP1

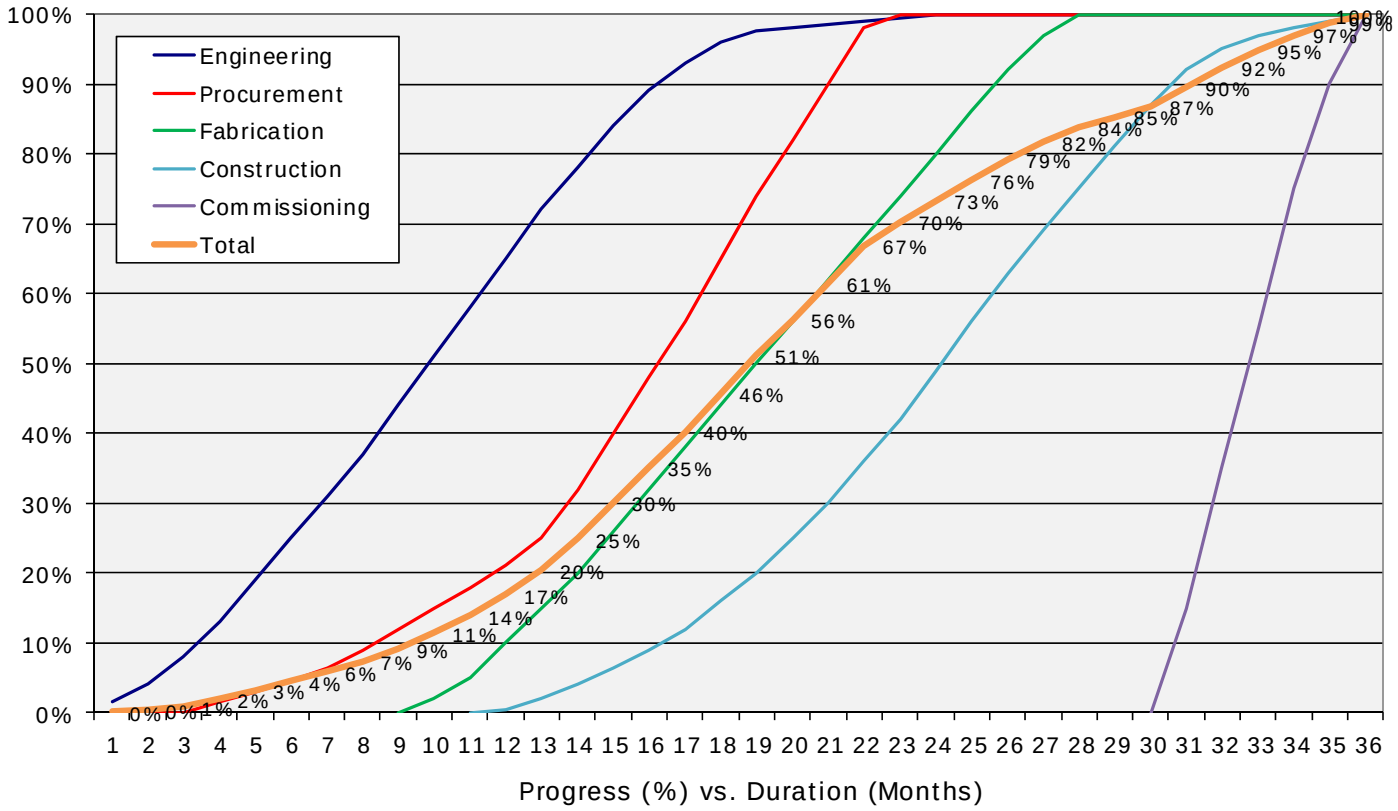
E: P: C: Comm:

Progress for WP2

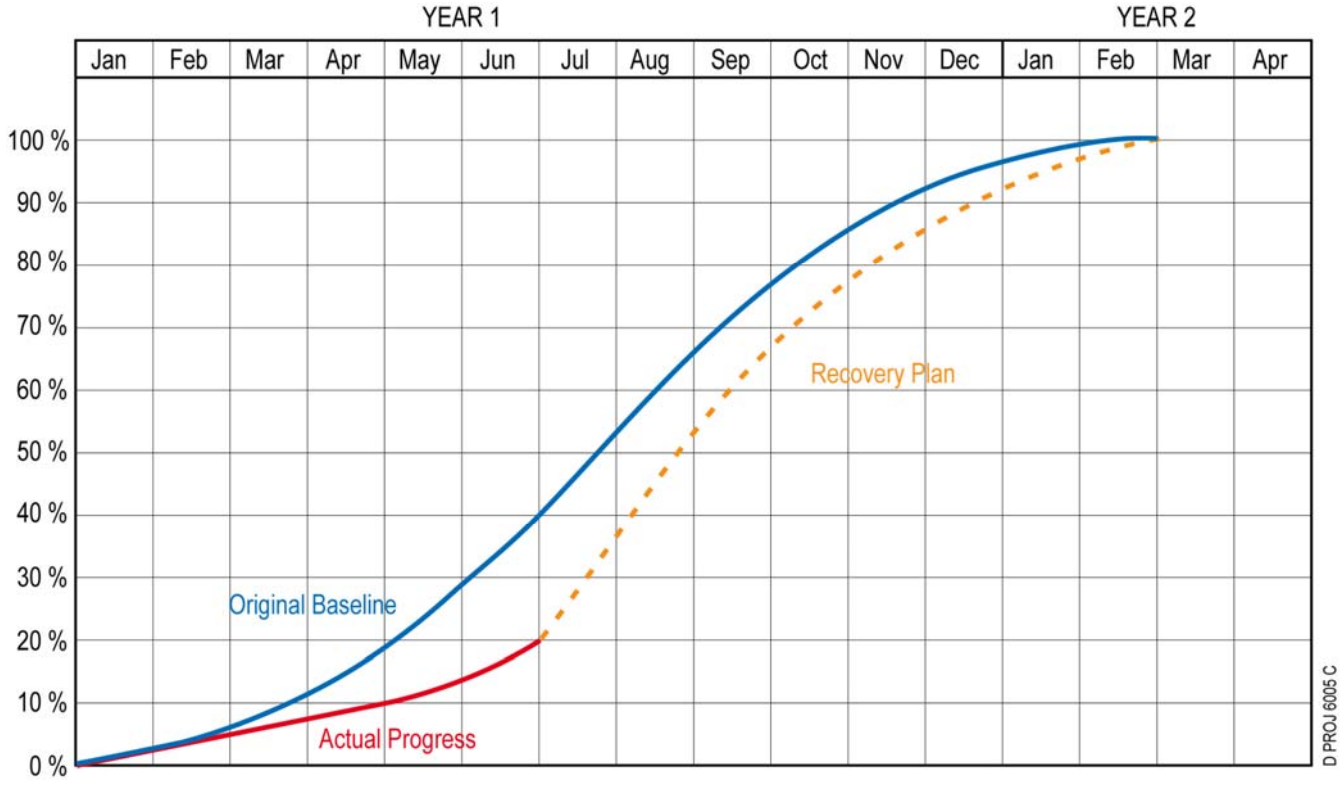
Weighted progress for WP2:

Overall Project progress:

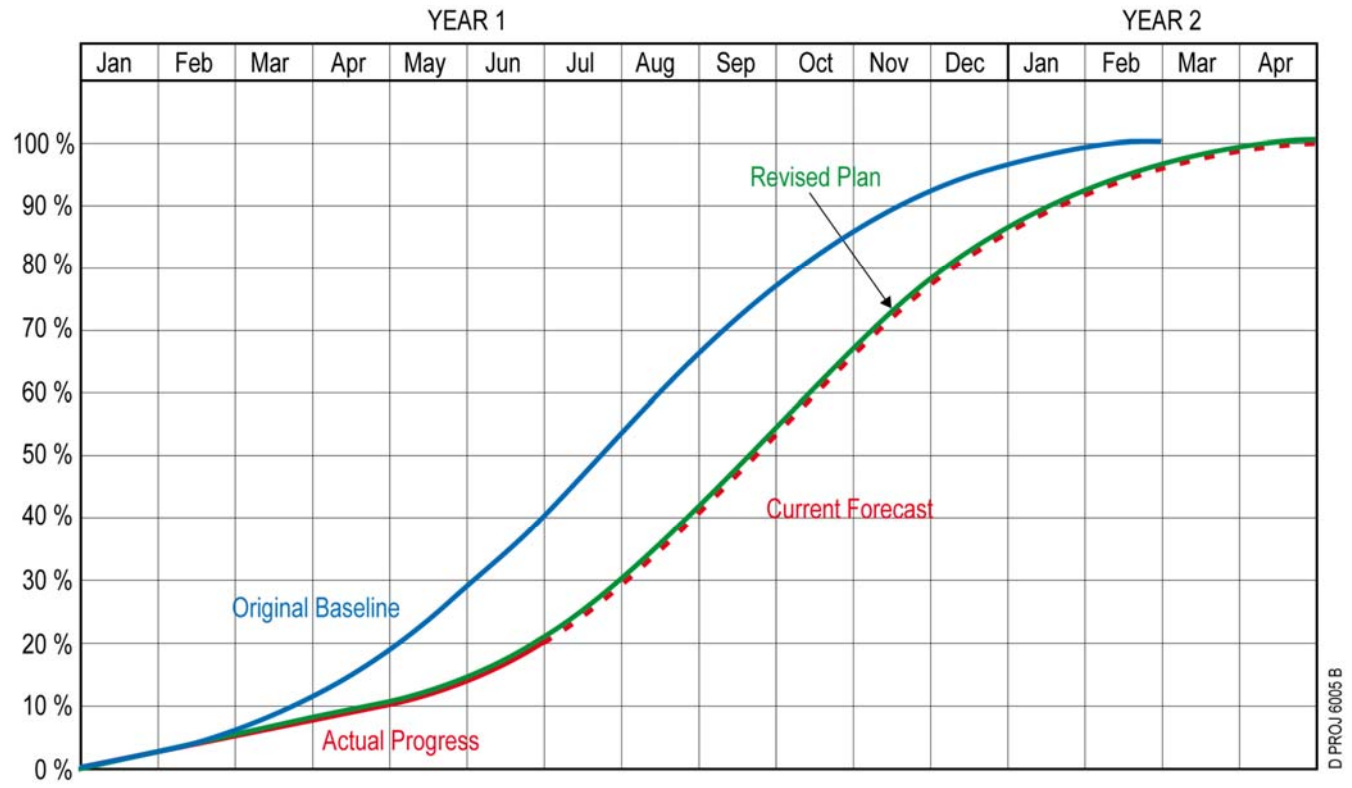
Typical progress curves



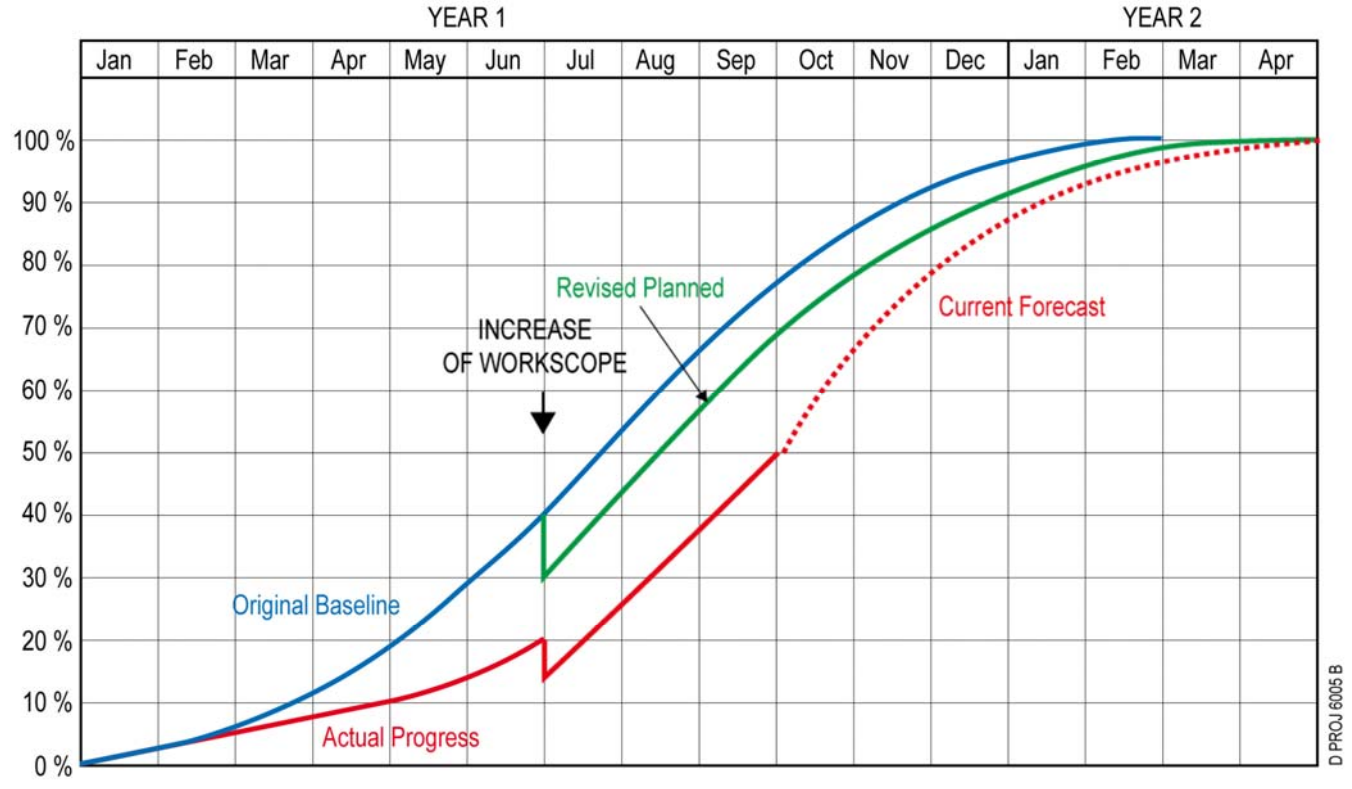
Recovery plan



Original baseline revision



Original baseline revision after increase of workscope



Summary

- Planning and scheduling are based on the Work Breakdown Structure (WBS) and Operations Breakdown Structure (OBS).
- Several levels of planning are defined which can be rolled up to form the high-level plan
- Definition of the critical path enables identification of tasks which require special follow-up, as any delay on those tasks will impact the overall schedule
- Schedule contingencies can be lumped together in a schedule-contingency reserve (days) to be used as needed
- By monitoring physical progress and productivity, adverse trends can be detected and corrective actions implemented



Foreword

Main objective

- Produce engineering deliverables to feed
  - Procurement activities
  - Construction activities
  - In a lesser extent, commissioning activities

Main tools and means

- Understanding of the key challenges of detailed engineering activities
- Interactions between detailed engineering and other project activities
- Lists and sequences of production of engineering deliverables
- Systems in place to control the review and approval of documents

Detailed Engineering objectives

Planning Detailed Engineering activities

Perform Engineering activities

Control Engineering

Objectives of detailed engineering

- To develop all documents of the FEED technical package in accordance with the contract (unless modifications are required, which are then to be agreed with Company- through approved changes management procedures: Engineering Queries/Deviation Requests)
- To timely issue Approved for Design (AFD) and then Approved For Construction (AFC): specifications, bill of quantities, drawings, scope of work, material requisitions, construction contracts packages, including timely processing of Company comments
- To timely review Vendors and sub-contractors documents
- In order to allow a timely execution of procurement, construction and pre-commissioning/commissioning
- To develop a work process of quality, i.e. which will minimize corrective revisions, field changes and avoid changes to procurement definition during its procurement/fabrication process

Engineering management

- Detailed Engineering objectives
- **Planning Detailed Engineering activities**
- Perform Engineering activities
- Control Engineering

Planning detailed engineering activities

Input

- **Project scope of work**
- **Project Execution Plan**
- **WBS**
- **Contracting strategy**

Tools & Techniques

Output

Planning Detailed engineering

- **Identify all detailed engineering deliverables including:**
  - Deliverables already prepared at FEED time, progressed/completed and to be re-issued until « AFC » and as-built status, where applicable
  - Additional deliverables, which complement the Front End package and provide all necessary detailed analysis, calculation, drawings, specification, to achieve procurement, construction, pre-commissioning/commissioning and operations & maintenance

(non-exhaustive list)

- **Prepare a schedule of all detailed engineering deliverables**
- **All these documents are to be filed in the Master Document Register**

Planning detailed engineering activities

Input

Tools & Techniques

- Expert judgment
- Experience from previous projects
- Resource analysis
- Subcontracting plan
- Planning software

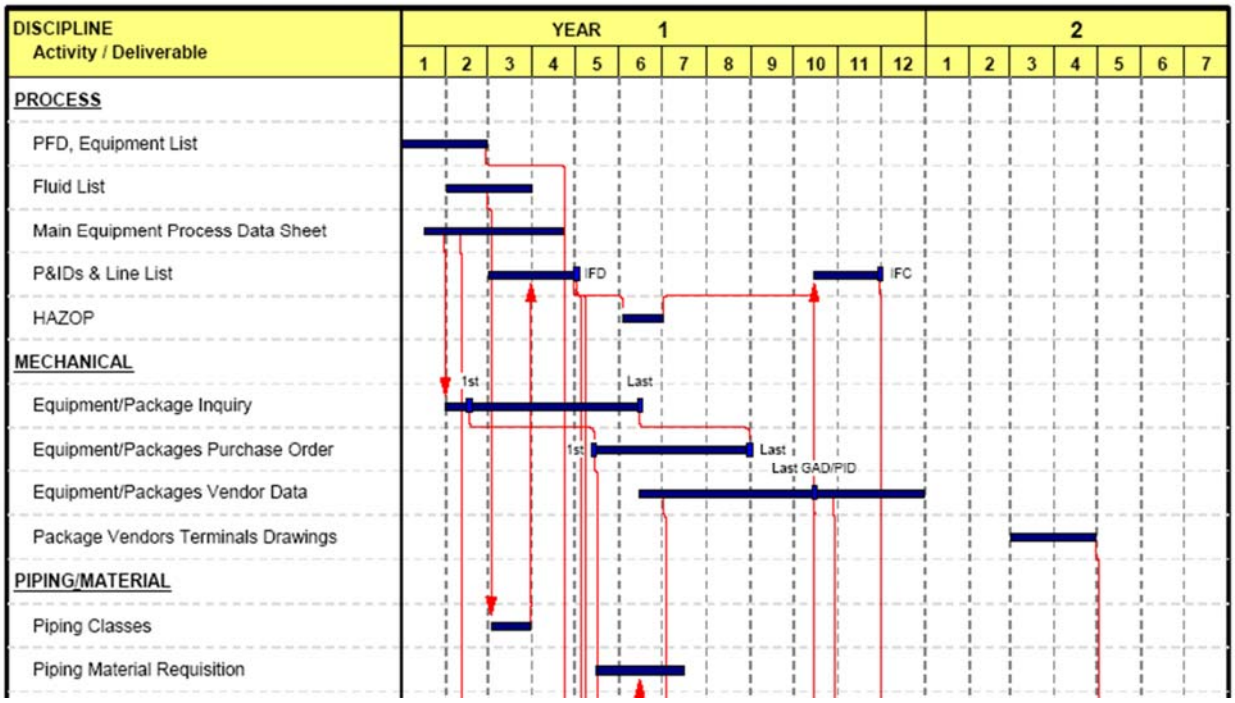
Output

Engineering management coordination

Engineering Management mainly coordinates with:

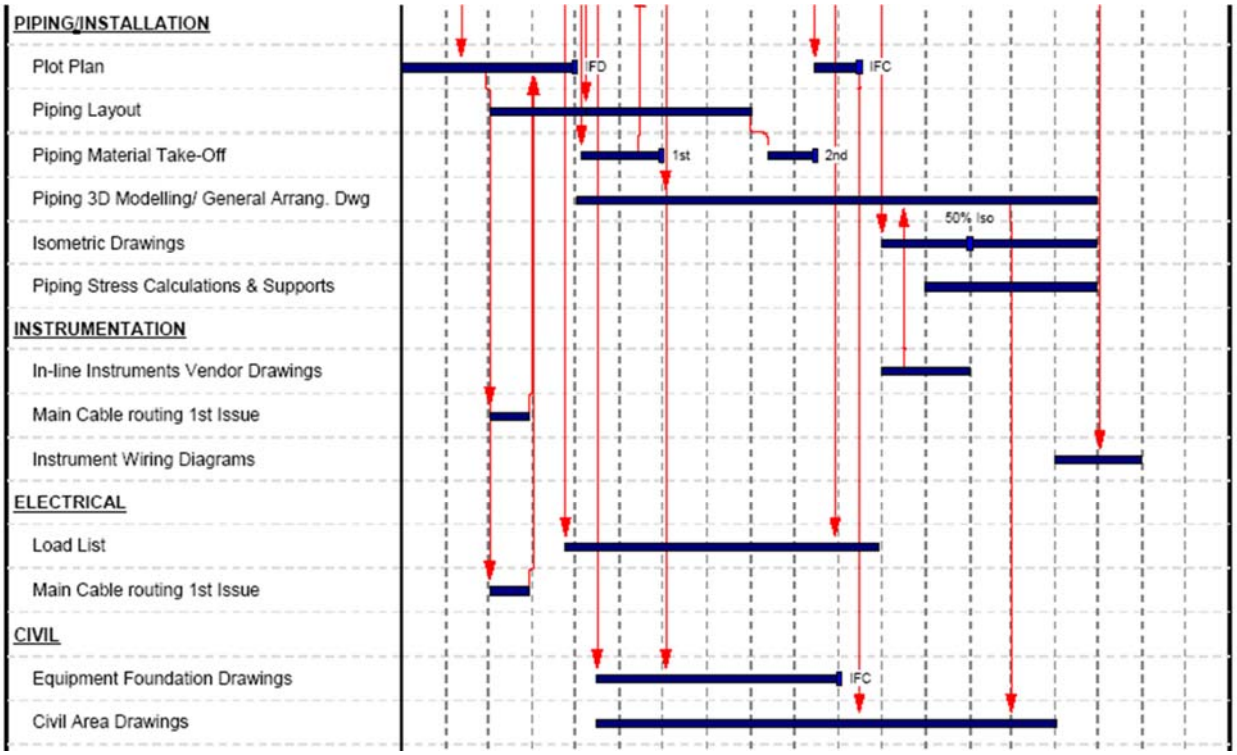
- **Procurement** for answers to Vendors technical queries, preparation of requisition list and requisitions, TBTs, participation to clarification meetings for major equipment and multi-disciplines packages
- **Fabrication/Construction Contracts Management** for preparation of Fabrication/Construction contracts Bid Packages technical part (scope, specifications, drawings, BOQS…), answers to technical queries, participation to clarification meetings
- **Site Construction team** for answers to queries, field engineering requests, site engineering surveys for existing installations

Main schedule interdiscipline relations (1/2)



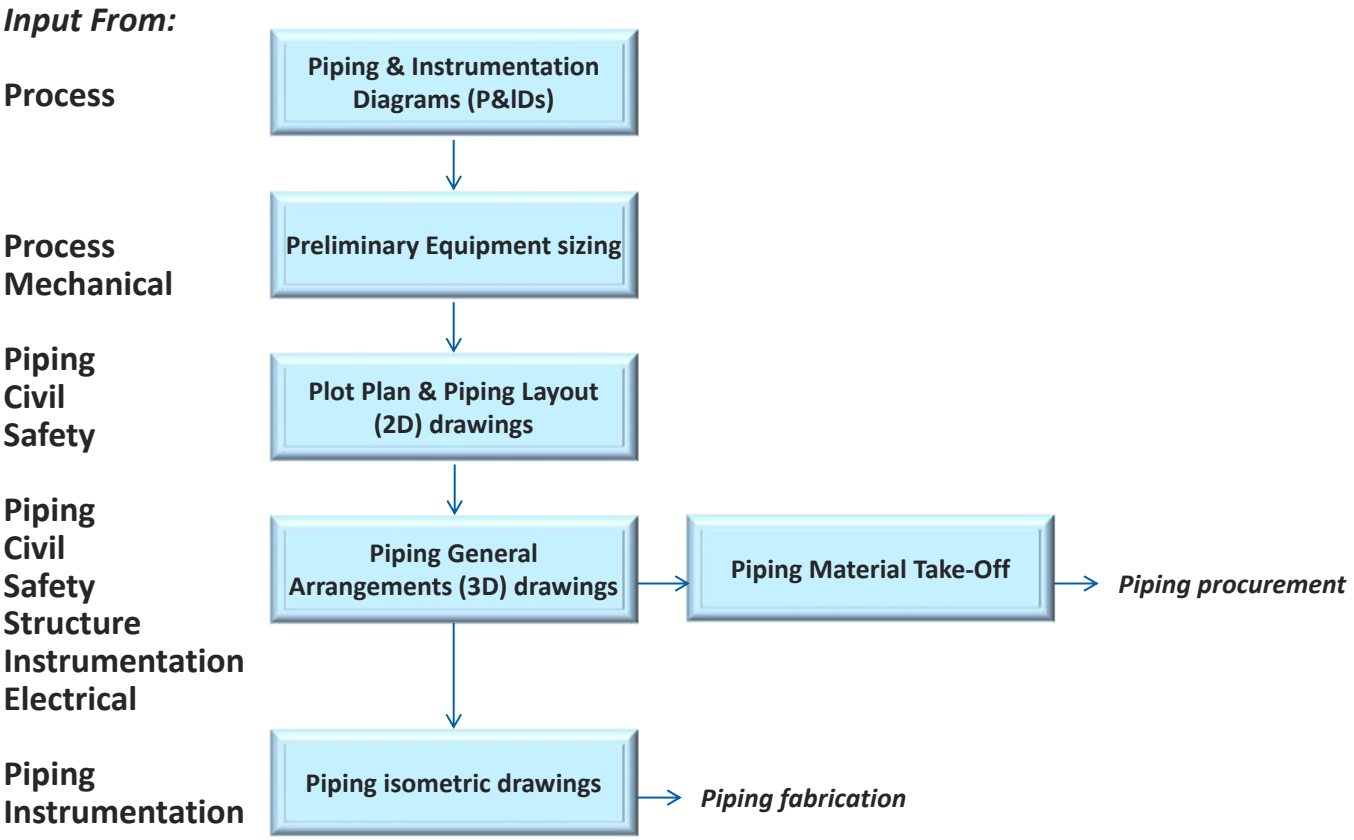
Source: The oil and gas engineering guide – Hervé Baron – Editions Technip - 2010

Main schedule interdiscipline relations (2/2)



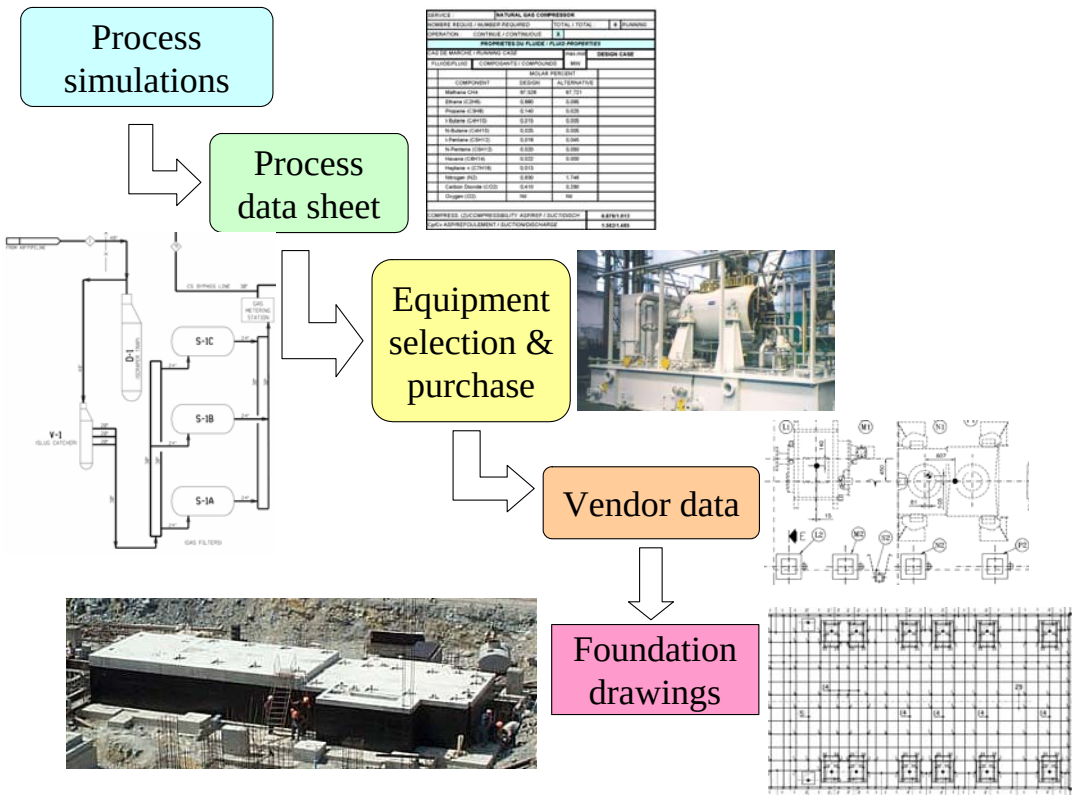
Source: The oil and gas engineering guide – Hervé Baron – Editions Technip - 2010

Example of flowchart for Piping acivities



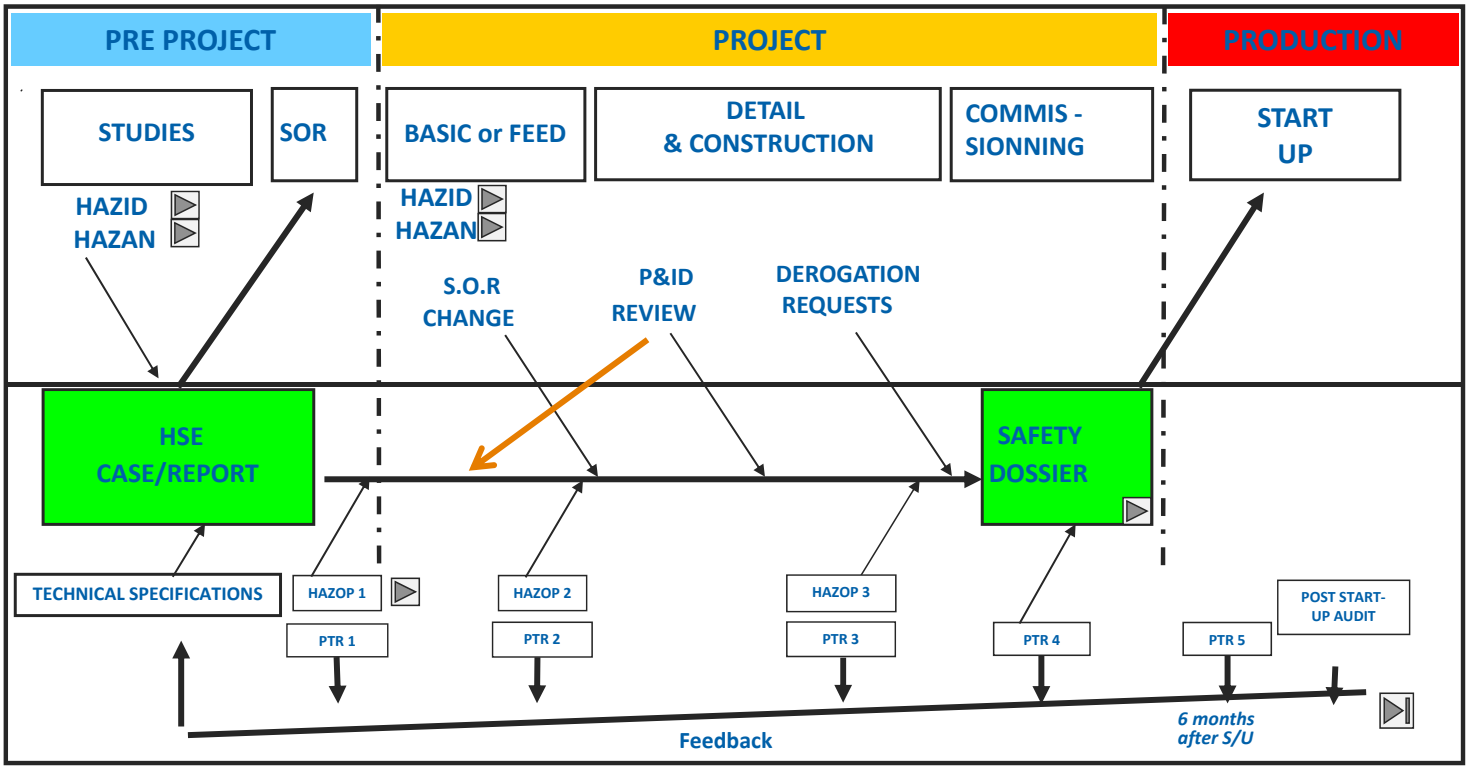
Source: The oil and gas engineering guide – Hervé Baron – Editions Technip - 2010

The challenge - matching the construction schedule



Source: The oil and gas engineering guide – Hervé Baron – Editions Technip - 2010

Plan Safety & technical company ("PTR") reviews (typical)



Planning detailed engineering activities

Input

Tools & Techniques

Output

- **Detailed engineering activities schedule**
- **List of deliverables**
- **Schedule of delivery**

Key documents for procurement and construction

- AFC Plot Plans and PIDs
- Area drawings to plan and check U/G works
- Civil drawings (U/G works, foundations) for civil construction start & progress
- Steel structures/pipe-racks detailed production schedule by areas (or modules) within units to permit procurement and fabrication of each structure
- Piping isometrics production schedules by areas (or modules) within units, to launch pre-fabrication (40% iso available) and allow pre-fab seamless progress
- 3D model used at fabrication or construction site and/or pipe-racks drawings
- Requisitions & TBTs to purchase equipment
- MTOs & requisitions/TBTs to purchase bulks
- Weight control for FPSO and Platforms topsides
- Timely processing to resolve field engineering queries
- Vendor documentation (up to final)

Master document register

Example

| | MASTER DOCUMENT REGISTER | TITLE BLOCK | | | | | | | | | | | | | | | DOC Mgt | | | | | | | | | | | | | | |

Engineering management

- Detailed Engineering objectives
- Planning Detailed Engineering activities
- **Perform Engineering activities**
- Control Engineering

Engineering management disciplines control key tasks

- List of activities per discipline
- Process design
- Mechanical equipment
- Safety and Environmental engineering
- Civil engineering
- Instrumentation, control & telecommunication
- Electrical
- Installation engineering

Engineering sub contractors management

- **O & G Engineering Contractors have skills in given Project Areas of O & G engineering. For large projects, major Engineering Contractors can organize in Partnerships, with split of work (according to their skills and resources allocation); they can also split their own scope of work between different offices of their world organization**
- **For some specific areas, specialized engineering (or EP or possibly EPC) sub-contractors may be selected (either by Company at FEED time, with contracts endorsed by Main Contractor), or by Main Contractor among Company approved sub-contractors, e.g.:**
  - Infrastructure contracts (e.g. jetties, MOF, camps, buildings, large sea water pumping stations)
  - Particular Process Plants (e.g. LNG Tanks, Sulphur Plants, Combined Cycle Power Plants…)
- **Engineering Management has a key role in management and coordination of these subcontractors; it includes:**
  - Sub contract Technical scope definition & interfaces management plan
  - Engineering Team resident at the sub-contractor's offices
  - Coordination procedures
  - Participation to project Reviews for this engineering scope
  - Management of subcontractor's documents review & approval
  - Etc.

Perform Constructability assessment

What is Constructability?

"The optimum use of construction knowledge and experience in planning, design, procurement and field operations to achieve overall project objectives".
(CII - Construction Industry Institute Definition)

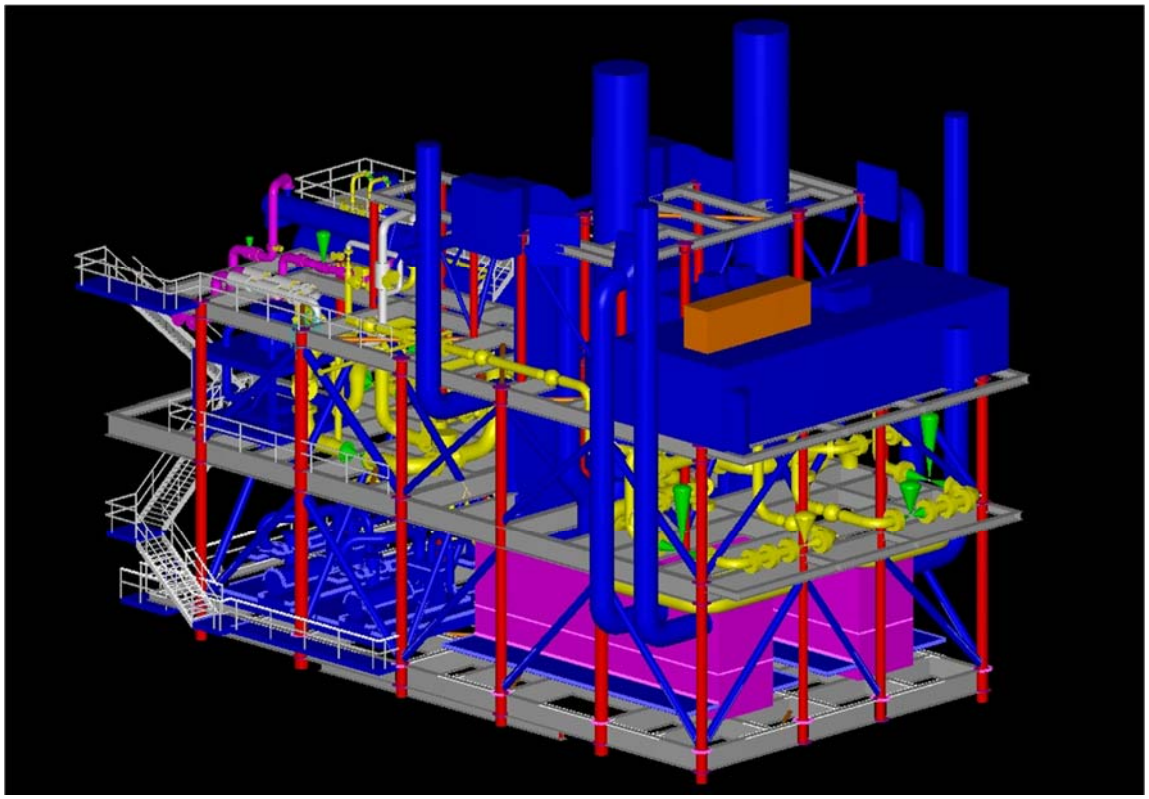
Due account of context/conditions of construction, as input to design, and to avoid rework or incompatibility (ex: barred access due to erection sequence

Constructability items in Lay-out review

- Construction and Commissioning Inputs into the Engineering
- TCF areas
- Traffic at site (equipment and personnel)
- Accesses for equipment delivery, construction equipment and rigging/heavy lifts, lay-down areas
- Accesses for modules delivery, lifting or rolling in-situ
- Accesses and lay-down areas for maintenance
- SIMOPs
- Pre-fabrication plans
- Module fabrication/delivery/integration plan for offshore facilities

Example of a 3D model

To check construction feasibility

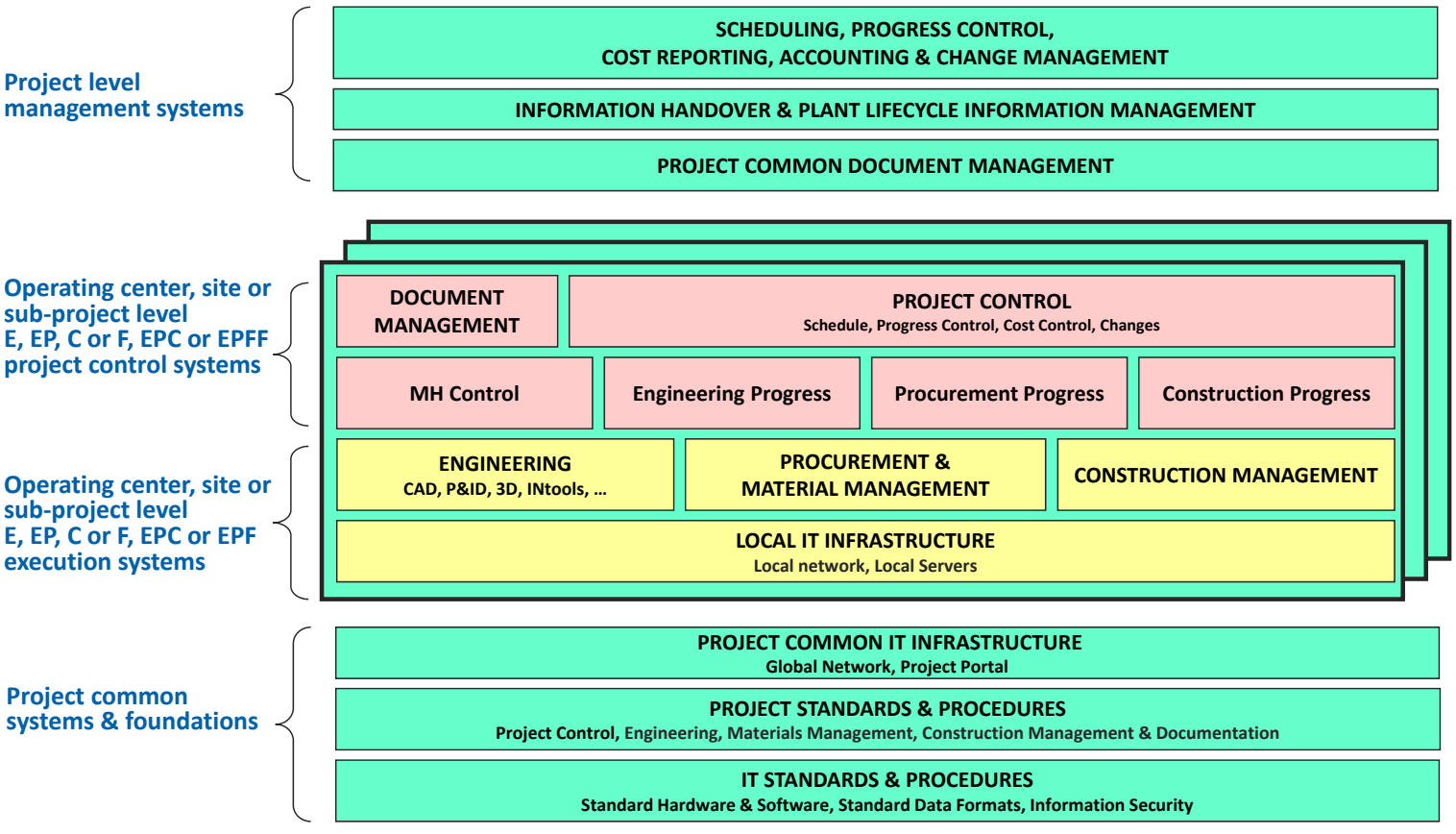


Typical engineering support to project reviews

Project Review	Scope	Performance	Company Attendance
Contract Review	Check contract requirements	At Project Start	
Risk Assessment Review	Identify risks & develop mitifation measures	Per Risks Assessment procedure	Per procedure
Constructibility review	Check Construction Equipment Accesses Check Construction Methods (Prfab/ Dressing/ Modularisation impact on Plot Check areas for TCF	Preferably before Plot Plan IFA issue; before IFD issue	Per procedure
Plot Plan Review	Check that plot plan incorporates requirements for process and other disciplines	Preferably before Plot Plan IFA issue; befire IFD issue	Per procedure
1st Model Review	Equipement arrangement Main structures arrangement Accesses	After Plot Plan IFD	X
2nd Model Review	~60% lines validate process operability validate maintenance accesses		X
3rd Model Review	~90% lines		X
HAZOP review	Check operations requirements	After PIDs IFD issue	X
SIL (or IPF) reviews	Check Protection by instruments functions	After HAZOP review	X
PTR review	Global Compaqny Technical Review	After HAZOP review and before IFC issues	X

Global project systems

Project in partnership – principle project systems levels



Engineering management

- Detailed Engineering objectives
- Planning Detailed Engineering activities
- Perform Engineering activities
- Control Engineering

Engineering management disciplines coordination and control key tasks

- Control disciplines progress by ensuring design information availability from other disciplines, Company (comments, answers to queries…), other engineering contractors if work splits or subcontracted, Vendors, or other parties (interfaces management), 3rd party review/acceptance, technical reviews, etc.
- Manage weekly inter disciplines meetings to check the above and discuss any related issue
- Check engineering progress & mobilization of engineering resources (current and planned)
- Organizes and Manages Project Reviews (Engineering Disciplines Contract Reviews, Constructability Review, Plot Plan and PIDs Design Reviews before AFD issue, HAZOP & SIL reviews, 3D model reviews)
- Coordinate with and control the progress (current and planned) of engineering subcontractors, and satellite engineering centres

Principle of detailed engineering company control

- **Organise KOM, ensure issue of general procedures,**
- **Review and/or Approval of engineering documents, by Company, 3rd party certification**
- **Attendance to Project engineering reviews, supply of comments and role per procedure**
- **Review and/or Approval of Contractor/Company/Third parties engineering meetings MOM (when applicable)**
- **Supply any information to be provided or obtained by Company:**
  - Basis Of Design information,
  - From existing operations/facilities
  - Interfaces with other packages
  - Derogation request approval
- **Ensure correct use/follow-up of Company project documentation system**
- **Engineering progress, including Licensors/vendors**
- **Quality control**

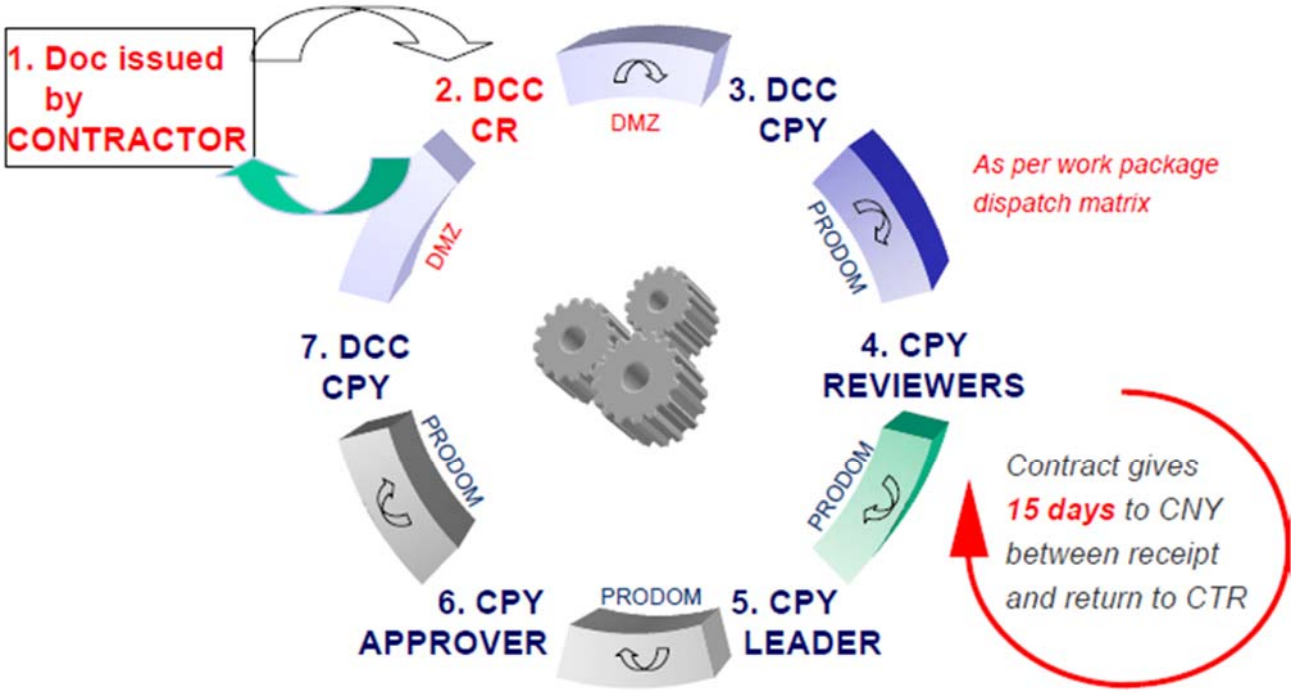
Engineering documents management system

- **EDMS manages 3 categories of documents:**
  - Technical Documents
  - Project Management Documents
  - Correspondence

COMPANY engineering documents management system

- Manages document workflow: issue/distribution/receipt/review/ approval/update
- Exchange of Documentation (through DMZ)
- Control of overdue Documents/Comments
- Security of data
- Search Facilities for all Project Users
- Reporting Facilities made easy for Project Engineering Manager
- Facilitate hand over of documents to Field Operations
- Full audit trail

Document workflow during engineering



Summary

- The detailed engineering team is the cornerstone of the technical organization. It will provide information enabling the Procurement team to order the equipment and the Construction team with information to perform their activities. The sequence of production of engineering deliverables must be adjusted to the construction strategy
- Detailed engineering must incorporate the input of the construction and future operating teams (results of project reviews)
- Control of engineering sub-contractors is key to the success, especially when they are located in remote places
- A reduced follow-on team has to be maintained throughout the construction phase to provide advice and clarifications
- A good Engineering Document Management System (EDMS) must be in place to facilitate review and approval of documents
- A complete “Final as-built” documentation is essential for future operations



Foreword

- **Main objective**
  - Prepare and implement a Procurement plan in order to source quality and cost effective services and equipment

- **Main tools and means**
  - Quality monitoring and surveillance plans
  - Selection of efficient and reliable sub-contractors
  - Finding the best compromise between cost and quality within the obligations of the owner
  - Verifying that the services and equipment provided by the contractors satisfy contract requirements

Objectives of the session

- **Understand key factors in the definition of the procurement strategy**
- **Know how to select efficient and reliable sub-contractors**
- **Understand the various competencies necessary in the project to ensure that the delivery chain will be work properly**
- **Understand how to focus the inspection effort on the most important or critical elements of the project**
- **Verify that the services and equipment provided by the contractors satisfy contract requirements**
- **Know the system required to monitor status of the purchased equipment until delivered to site**

Procurement management

- About procurement activities
- Plan Procurement activities
- Conduct Procurement activities
- Control Procurement activities
- Close procurements

Procurement Management General Objectives

- To deliver equipment & commodities in accordance with the requisitions, i.e contract requirements (e.g. FEED technical package…), unless modifications are required , which are then to be agreed with Company – through approved procedures (Engineering Queries/Deviation Requests).
- To deliver Vendors drawings & information on-time to allow engineering progress.
- To control review Vendors of documents to ensure Vendors fabrication continuity , testing and delivery without problems.
- To deliver equipment & commodities (incl. spare parts) through a work process of quality, i.e. which will ensure a delivery in conformity with requirements, fully completed and tested to avoid fixing problems at fabrication, construction or integration sites.
- To deliver equipment and bulks on time per schedule to allow fabrication/construction progress.

Procurement management

- About procurement activities
- **Plan Procurement activities**
- Conduct Procurement activities
- Control Procurement activities
- Close procurements

Plan Procurement activities

Input

- Long Lead Equipment list from Owner
- Equipment list from detailed engineering
- MTO from detailed engineering
- Project schedule
- Risk register
- Vendor data base
- List of Company approved vendors
- Company technical referential

Tools and techniques

Output

Project procurement strategy

Procurement strategy will focus on:

- **Worldwide procurement to optimize Vendor selection and price, in-line with the contractual Vendors List**
- **Project standardization policy in particular for commodities such as instrumentation (control valves, transmitters…), PLC's, LV electrical motors, transformers, switchgear (sub-suppliers lists for main Vendors at bidding time) …**
- **Origin of Supplies according to Project constraints (Financing, Local Content…)**
- **Preference for quality suppliers in the area which may minimize delivery schedule and global cost when considering shipment & inspection costs.**

Procurement of long lead items/critical equipment (« company items »)

- **Vendor Contracts for LLIs/Critical Equipment will generally be assigned to the EPC contractor, who will need to endorse these (normally during EPC Tendering). This may lead to some difficulties in execution of these deliveries, such as interfacing and connecting to other equipment:**
- **Company contract formats are usually « Contract » type and not « Purchase Order » type as normally used by EPC contractors; they are sometimes:**
  - Not fully in-line with the EPC Contract requirements.
  - Made of initial enquiry documents + sets of clarifications (which are not necessarily all clearly understood and may bear contradictions…) + Vendors proposals.
  - Not anticipating the role/needs of the EPC Contractor between Vendor and Company.
- **The EPC Contractor will need to rationalise these contracts and to apply execution procedures in-line with his requirements as far as possible.**

Company items: LLIs and critical equipment

		POTENTIAL LLI	CRITICAL EQUIPMENT		
		To be checked for each Project	To be checked for each Project	Advantages	Disadvantages
VESSELS / COLUMNS	LARGE FRACTIONATION COLUMN			Vendors drawings available earlier	
	COKE DRUMS	X (SPECIAL METALLURGY)	X (if not a LLI)	Vendors drawings available earlier	
HEAT EXCHANGERS	MCHE for LNG			Vendors drawings available earlier	
	SEA-WATER H/E WITH Titanium			Integration offshore	
AIR COOLERS	Large Banks	X (offshore)		Vendors drawings available earlier	
		X (onshore modularized)		Integration offshore	
LNG Refrigerant, Propane Refrigeration	GT Compressors (FR9, Fr 7 or aeroderivatives driven)	X			
Export Gas, Gas Lift, Injection Gas	GT Compressors (Aeroderivatives driven)	X (offshore)	X (if not a LLI)	Integration offshore	
		X			
Propane Refrigerant Compressors	GT or aeroderivative driven	X			
		X			
PUMPS	Large Oil Field Pumps		X (if not a LLI)		
SPECIAL PACKAGES	Decoking system			Vendors drawings available earlier	
PIPELINE ITEMS	Large Size and lenghts , heavy walls	X			
LARGE CRYOGENIC VALVES			X		
CONTROL SYSTEMS			X	Company standardisation	Difficult to control the price ; large growth during detail
(DCS/ESD/F&G)					
REFRIGERATED TANKS (LNG, LPG)		X			
POWER GENERATORS	GT or aeroderivative driven	X (offshore)	X (if not a LLI)	Integration offshore	
AIR COMPRESSORS		X (offshore)	X (if not a LLI)	Integration offshore	

Plan procurement activties

Input

Tools and techniques

- Market research
- Criticality rating of the equipment

Output

Equipment criticality assessment

- **The Project Manager is responsible for the Criticality Assessment, which will be carried out as soon as the equipment list is available, and shall occur prior to enquiry issue.**

- **The Project Manager will convene a meeting to perform the Criticality Assessment, comprising:**
  - Project Manager and/or Engineering Manager
  - Project Quality Manager
  - Process Manager, Process Engineer(s)
  - Lead Discipline Engineers, Discipline Engineer(s)
  - Procurement (including Inspection) Department representative(s) as appropriate

Criticality rating of equipment – Typical

- **8 evaluation criteria, graded on a scale of 1 to 4, 1 representing zero impact of the criterion on the equipment criticality and 4 representing major potential impact.**
  - Potential impact on SAFETY AND/OR ENVIRONMENT resulting from failure
  - Potential impact on PLANT OPERABILITY resulting from failure
  - Potential impact on OPERATING COSTS resulting from non-availability or replacement of the equipment
  - SEVERITY OF SERVICE resulting from services conditions (P, T, corrosion…)
  - DESIGN COMPLEXITY
  - MANUFACTURING/TESTING COMPLEXITY
  - ENGINEERING SCHEDULE IMPACT resulting from delay in engineering, manufacturing or delivery of the equipment
  - OVERALL SCHEDULE IMPACT resulting from delay in engineering, manufacturing or delivery of the equipment.

Definition of typical inspection levels

Inspection levels definition				
	Vendor quality rating			
	1 Very good	2 Good	3 Standard	4 Monotoring required
Commodity. Crit. Rating				
High (24 to 32 points)	1	1	Excluded	Excluded
Medium (16 to 23 points)	2	2	1	Excluded
Low (8 to 15 points)	5	4	3	2
Not critical (0 to 7 points)	5	5	4	3

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Plan procurement activties

Input

Tools and techniques

Output

- **Procurement management Plan**
- **Procurement scope of work**
- **Procurement documentation**
- **Selection criteria**
- **Schedule of delivery**
- **Inspection program**
- **Requests for deviations**

Major components of the bid response

- Program of work and list of deliverables
- Schedule baseline
- Performance reporting
- Organization charts - Roles and responsibilities of the key personnel
- Contractor place of performance
- Pricing format
- Payment terms
- Place of delivery
- Inspection and acceptance criteria
- Warranties
- Product support
- Limitation of liabilities
- Fees and retainer
- Penalties
- Incentives
- Insurance and performance bonds
- Subcontractors selection and control principles
- Change requests handling
- Termination clauses and procedures for conflict resolution

Procurement management

- About procurement activities
- Plan Procurement activities
- **Conduct Procurement activities**
- Control Procurement activities
- Close procurements

Procurement activities

- **Purchasing**
  - Main equipment
  - Small equipment
  - Bulk materials
  - Spare parts
- **Expediting**
  - Document delivery
  - Equipment delivery
  - Invoice verification
- **Inspection**
  - Progress control
  - Quality Control
  - Factory Acceptance Tests
- **Transportation**
  - Storage
  - Packing
  - Loading
  - Carriage
  - Custom clearance

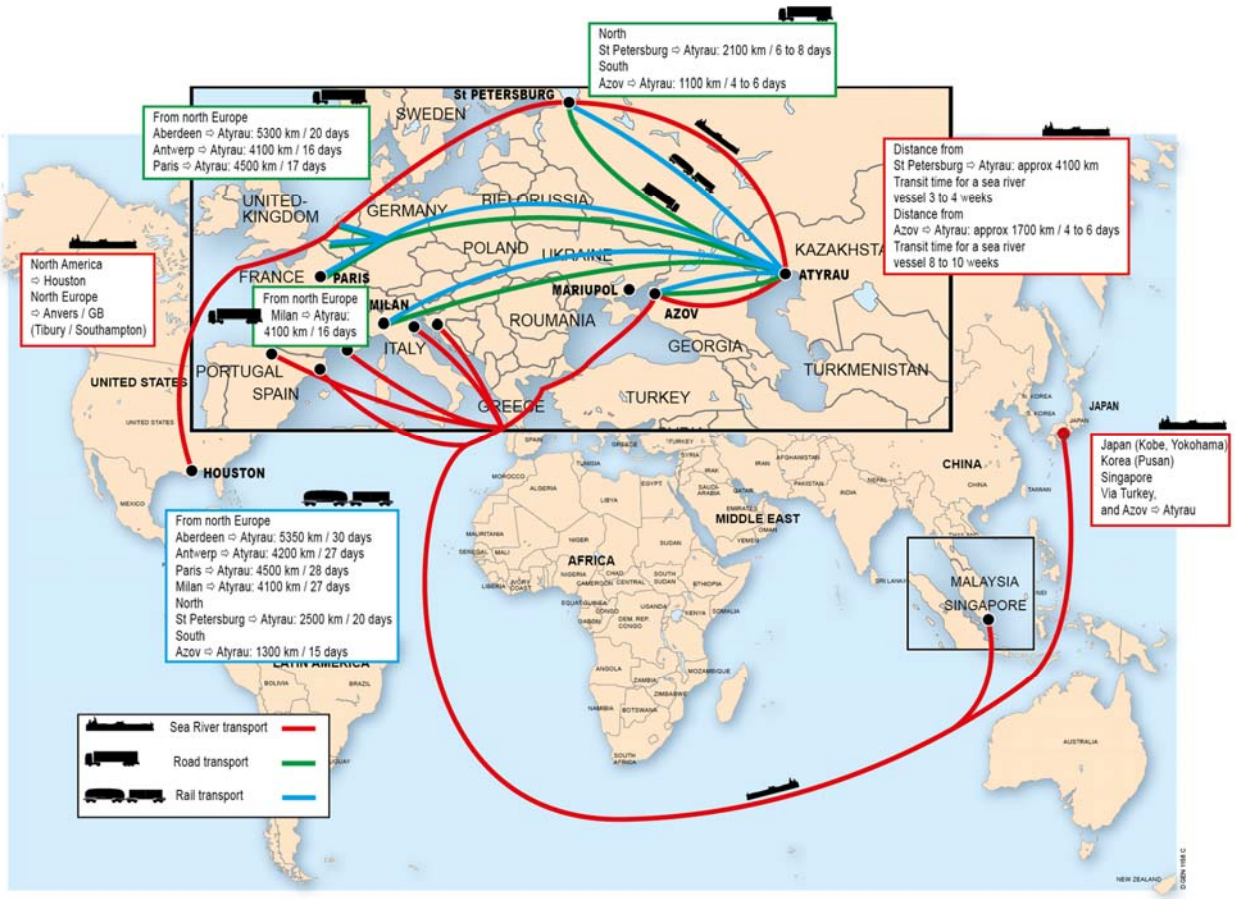
Procurement Management Process (Purchasing, Expediting)

Procurement Manager	Prepares Procurement Plan
	Organizes and Controls Proc.
	Controls Tendering Procedure implementation per contract / project requirements
Purchasing Manager	Prepares Purchasing Procedures
	Prepares Project Vendor Lists
	Prepares Vendors Short Lists for enquiry in coordination with engineering
	Organizes (Com. & Tech.) Clarification Meetings with Major Vendors
	Coordinate with cost control for monthly cost reports proc. info. (committs, forecast..)
	Manages Purchasing effort
Purchasers (usually by commodities families)	Prepare inquiries, Commercial Bids Tabulations
	Expedite Bids preparation and receipt & prepare Bids Enquiry Status
	Prepare P.Os & P.Os amendments
	Before P.O official issue , prepares draft P.O format for Vendor Acceptance
	Coordinate with Disciplines (requisitions issuers) for clarifications, TBTs...
Expediting Manager	Prepares Expediting Procedures
	Issues Monthly Material Status Report
	Prepares monthly procurement progress report
	Manages Expediting effort
Expeditors	Expedite at Vendors for progress (desk or shop visits) & provide MSR status
	Obtain 1st Vendors drawings (then Vendors Documents Controllers)
	Input procurement info in the Materials Managt System

Procurement Management Process (Inspection, shipping)

Inspection Manager	Prepares Inspection Procedures
	Prepares Inspection Plan incl. Participation of engg specialists, Company , Third Party inspection, use of agencies
	Prepares Inspection & Test Plans (ITPs) per Level of Inspection / Criticality rating in coordination with engineering
	Organizes Pre-inspection meetings
	Prepares and keeps up-to-date the inspection visits schedule
	Special cases (e.g compressors) : continuously monitor fabrication (resident inspectors)
	Prepares work orders to agency inspectors
	Maintain NCR list & status (concession requests) in coordination with engineering
Inspectors	Perform inspection visits ; prepare inspection reports (review by engineering)
	Organize inspection visits
	Prepare Inspection Releases Certificates (after Vendors final documentation delivery)
	Prepare Non Conformity Reports NCR
Shipping Manager	Prepares Shipping & Import / Customs clearances Procedures
	Prepares forwarding / shipment plan
	Prepares Shipment List
	Prepares Enquiries to Forwarding Agents , Bid Tabs & recommendation
	Prepares Enquiries for special transporation (e.g RO/RO,LO/LO vessels…), Bid Tabs & recommendation
Traffic agents	Assist Shipping Manager, expedite shipping / clearances process
	Organizes urgent shipment (air freight..)when required
Forwarding agent(s)	Organizes shipment
	Maintain in-status shipment status
	Obtain Bills of Lading

Shipping: Some typical Routes to Kashagan Field



Traffic



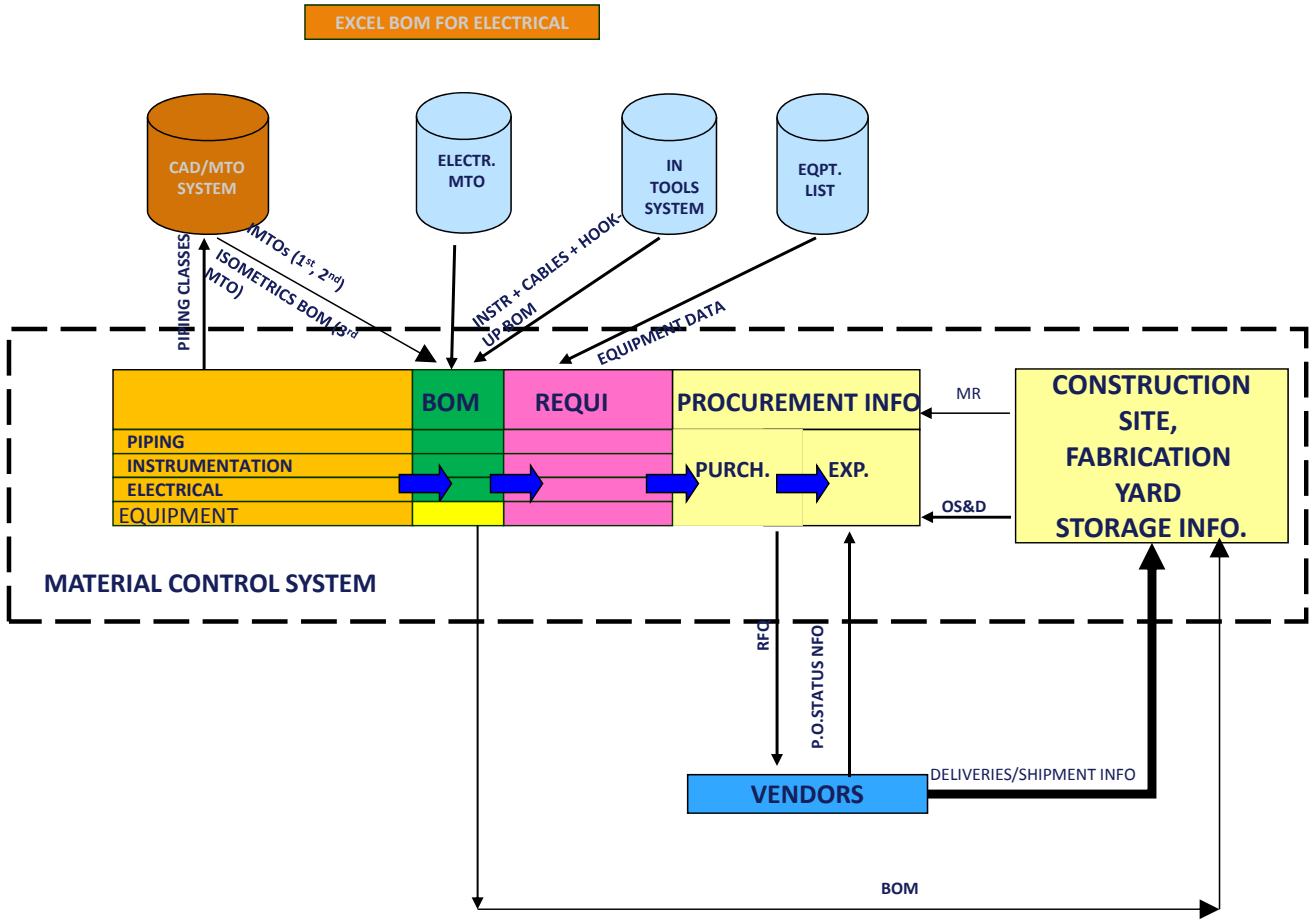
Procurement management

- About procurement activities
- Plan Procurement activities
- Conduct Procurement activities
- Control Procurement activities
  - Procurement audits
  - Inspection program
  - Surveillance plan (see quality session)
- Close procurements

Material control system

- **Major EPC Contractors have implemented an integrated Material Management Control System which incorporates all data on commodities requisitioned, Bills of Bulks Materials (BOM) and their procurement status.**
- **Purchasing, expediting, inspection, shipping, receiving and site storage and handling information is loaded in the system, successively by engineering, procurement (expediting) and construction.**
- **The system allows individual tracking of bulks items from MTO's to the site**
- **At Site it allows to:**
  - Continuously update the material warehouse inventory upon material receipts
  - Issue OS&D reports
  - Know the status of material deliveries and check or forecast availability of material for pre-fabrication or erection in order to plan the fabrication/construction or expedite lacking items (this can also be done at Home Office).

Typ. materials control system



Procurement management

Key elements

- **Procurement Plan confirmed by all players:**
  - Procurement manager (with Company services support)
  - Vendors, Suppliers for main E (equipment) and BM (bulk material) (E&BM)
  - Construction manager for site requirement,
  - Shipping manager for E&BM condition of transport up to site delivery,
- **Bidding and Tendering procedure confirmed and effective**
- **Sound and complete Orders condition and documentation:**
  - General, contracting and commercial,
  - Technical definition and scope limit of supply
  - Inspection and 3rd party requirement
  - Vendors assistance and guarantee
  - Final documentation
- **Procurement team organization empowered, able to act and react rapidly to changing conditions**

Company control of procurement (LSTK Project)

Company Control of Procurement (LSTK Project)	
Procurement procedures	A (for compliance with Contract)
Procurement Plans	A (for compliance with Contract)
Material Status Report	R (with monthly reports)
Shipment list	R (with monthly reports)
Procurement progress	R (with monthly reports)
Requisitions good for inquiry	I (Company R or A of engineering docts)
Requisitions good for purchase	I (Company R or A of engineering docts)
Vendors Lists	A (additions to list in Contract : per Contract rules)
TBT	R
CBT without prices	R
Inspection schedule	R
Inspection visits	Participates per Company inspection plan
ITPs	A (may depend on Level)
Inspection reports	R
NCR list	R
Vendors Technical Documents	A , R or I according Contract
	A: Approval; R: Review; I: Information

Pressure Vessels Inspection Levels (Typical)

PRESSURE VESSELS	ITEM :	GUIDELINES FOR CONTRACTOR'S INVOLVEMENT FOR BS 5500 VESSELS AND ASME VESSELS	Page

	STAGES OF INSPECTION	EXTENT OF INVOLVEMENT					
		VESSELS CAT. 1		VESSELS CAT. 2		VESSELS CAT. 3	
MATERIALS	PREINSPECTION MEETING		H		H		H
	MATERIAL TEST CERTIFICATES		R		R		R
	IDENTIFICATION OF MATERIALS TRANSFER OF MARKING		W		I/R		R
	SUPPLEMENTARY MECHANICAL PROPERTIES		R		R		R
	SUB–ORDERS		R		R		R
QUALIFICATIONS	WELDERS / OPERATORS QUALIFICATIONS		W/R		W/R		R
	WELDING PROCEDURE SPECIFICATIONS WPS + REPAIR PROCEDURES		R		R		R
	WELDING PROCEDURE QUALIFICATIONS PQR RECORDS		H/R		W/R		R
	NDT OPERATORS QUALIFICATIONS AND NDT PROCEDURES		R		R		R
	MANUFACTURING PROCEDURE		R		R		R
NON–DESTRUCTIVE TESTING	DYE PENETRANT/MAGNETIC PARTICLE		W		I		I
	ULTRASONIC EXAMINATION		W		I		I
	RADIOGRAPHIC EXAMINATION REVIEW OF RADIOGRAPHS		R		R		R
	FERRITE / HARDNESS CHECKS		W		I		I
	PAMI TEST (AS APPLICABLE)		H		H		H
Destructive Testing	PRODUCTION TEST COUPONS		W		I		H
FABRICATION	CORRECTIVE ACTIONS FOR NON–CONFORMITIES		W		I		R
	BEVEL PREPARATION / TACKING		I		I		I
	BACK GOUGING BEFORE WELDING REVERSE SIDE		I		I		I
	WELDING PARAMETERS / OPERATION + REPAIRS		I		I		I
	FORMING		I		R		R
	P.W.H.T. (LOCATION THERMOCOUPLES, REVIEW OF RECORD)		I/R		R		R
	DIMENSIONAL / VISUAL		H/W		H/I		H/I
	HYDROSTATIC TEST / PNEUMATIC TEST AS APPLICABLE		H/W		H/W		H/W
	TIGHTNESS TEST (AS APPLICABLE)		H/W		H/W		–
PREPARATION FOR SHIPMENT	SHOT BLASTING / PAINTING		I		I		R
	DRYING / PRESERVATION		W		I		I
	PACKING / MARKING		W		W		I
VENDOR DOCUMENTS	MANUFACTURING REPORTS		H/R		H/R		H/R

- **W: witness point (notification by Vendor 10 days in advance), but option for inspector to attend**
- **H: hold point (notification by Vendor 10 days in advance), but inspector to attend & provide approval before further processing by Vendor**
- **R: Review point: review & acceptance of Vendor documentation. No formal notification**

Surveillance Plan

COMPANY Quality Surveillance	Criticality Rating of Units			
	1	2	3	4
Supplier Quality System audit **prior to** commitment	X			
Review of supplier Quality Manual **prior to** commitment	X	X		
Supplier Quality System audit during the WORK	X	X		
Review of supplier Quality Plan	X	X	X	
Review of supplier Quality Control (Insp. & Test) Plan	X	X	X	X
Independent review of supplier engineering documents	{1}			
Systematic review of supplier engineering documents	{1}	{1}		
Selective review of supplier engineering documents	{1}	{1}	{1}	
CONTRACTOR resident inspector at supplier's	X			
CONTRACTOR part-time inspector at supplier's	X	X		
CONTRACTOR inspector visits at supplier's	X	X	X	
Independent Inspection (certifying) Authority	{1}	{1}	{1}	
Review of "sub-suppliers" list	X	X		
Review of supplier purchasing documentation	X	X	X	
Attendance to pre-inspection meeting at supplier's	X	X		
Attendance to co-ordination meeting with supplier	X	X	X	
Second level direct inspection at Hold points	X	X		
Witness supplier QC specific stages	X	X	X	
Witness of final factory acceptance tests	X	X	X	X
Intermediate review of suppliers QC records	X	X		
Review of suppliers final QC & Certification(1) dossier	X	X	X	X

Workshop inspection

- When to organize a workshop inspection? How to organize it?
- Either the equipment represents a technical critical element, or is an equipment on the critical path of the project.
- Some equipment such as pipeline tubes or main pipeline valves require also workshop inspection due to the size, the quantity of material involved and the unique role of any pipeline in a project.
- It is the choice of the Company to decide whether its own personnel, the EPC contractor alone or a third party will be called to perform the inspection at the supplier workshop.
- Inspection has to be organised along a planning prepared as soon as possible after contract award.

You don't get what you expect, you get what you inspect

Procurement management

- About procurement activities
- Plan Procurement activities
- Conduct Procurement activities
- Control Procurement activities
- **Close procurements**

Closing procurement

- Provides formal written notice that the equipment has been delivered and that the contract obligations have been met
- Technical documentation (as built file)
- Outstanding or non conforming items
- Pending warranty issues
- Acceptance certificates (provisional, final acceptance certificates)
- Lessons learnt documentation
- Recommendations for improvement

Summary



- The procurement strategy should be defined at the beginning of the project (international sourcing vs local sourcing, standardization policy for the project…
- The list of possible suppliers should be drawn up with the Client (approved vendor list in the contract)
- A rating system must be established to determine the criticality of the equipment for the project
- Based on this criticality rating, inspection and surveillance plans should be defined together with the resources needed to implement them
- For remote project locations, transportation can be an important issue and require considerable planning and resources
- An efficient material control system is necessary to track the equipment until delivery on site



Construction

Objectives of the session

- Present specific aspects of O&G projects in terms of construction
- Present organizations and contracting strategies
- Develop the different construction strategies which can be implemented
- Indicate scheduling criteria to maximize efficiency of the construction activities
- Detail progress and efficiency measures

Construction and installation management pre-requisites

- **Thorough, realistic Construction Strategy and Plan confirmed by main players:**
  - Construction manager (with Company services support)
  - All contractors, and their main subcontractors
  - Procurement manager for equipment delivery at site
  - Shipping manager for Equipment & Bulk Material (E&BM) condition of transport up to site delivery
- **Tendering procedure confirmed and effective**
- **Sound and complete Contracts condition and documentation**
- **Temporary and final site operability (access, preparation, contractors facilities, material storage, prefabrication, etc.)**
- **Contractors mobilization, coordination**
- **Construction team organization empowered, able to act and react rapidly to changing conditions**

Construction management

Fabrication and construction activities

- **Construction challenges**
- **Construction strategies**
  - **Modular construction**
  - **On site construction**
- **Contracting construction activities**

Planning Construction activities

Performing Construction activities

Controlling Construction activities

Construction challenges: project size

- **Large Projects**
  - As an average
    - Over 10 MM const mhrs
  - Case of Mega single projects in the Middle East
    - 30 to 50 MM const mhrs
    - TIC ranging from 3 to 5 GUSD
    - Direct manpower peak: 10 to 20,000 pax
- **Main Contractor site supervision may reach 300 pax**
- **Nationalities at site may surpass 30**
- **Challenge: how to deal with such manpower in terms of**
  - Coordination and communication?
  - Accommodation?
  - HSE?



On site vs. modularization approaches

Parameters to consider

- **Cost and amount of labour capable of being removed from the construction site**
- **Transportation and logistics considerations**
  - Cost
  - Feasibility
- **Local and worldwide module fabrication contractors workload and availability**
- **Economics of the various options**
- **Main constraint: to be effective and allow complete module assembly prior to delivery, the module design should be substantially complete before fabrication commences**

Modularization benefits

- **Removes construction hours from site**
- **Reduces site congestion and increases availability of work fronts**
- **Improves construction schedules**
- **Minimises safety risks**
- **Improves productivity and cost for the part of the work fabricated in shops**
- **Reduces scaffolding on site**

Modularization risks

- **Engineering needs to be complete earlier than for stick built construction**
  - In particular: electrical heat tracing, insulation, …
- **Suppliers data is critical to modules design and should be available in time**
- **Structural steel delivery is on the critical path in the modules assembly schedule**
- **Modules being shipped to site incomplete or late result in costly field work and out of sequence erection**
- **Supply chain management more complex in case of several modules fabrication yards**
  - Bulk material not ordered in time
- **Transportation means must be secured well in advance**

Snohvit LNG project





Modular construction and Integration at a Spanish yard

Modularization



Specificitiess of a modularized project

- For offshore transportation, requires a MOF facility to berth vessels for longitudinal (RO/RO) or lateral (RO/RO or LO/LO) unloading of the modules on SPMTs (Self Propelled Modular Transporters)
- For onshore transportation, access routes (road, rail) to be identified and limitations in terms of tonnage to be defined
- For a large offshore project, modules tonnage may range from 40,000 tons to 200,000 tons; several fabrication yards may be required
- Transportation Vessels are in limited in numbers and should be hired well in advance (pre-commit before project sanction)
- SPMTs Transporters are also limited in numbers and should also be hired well in advance (pre-commit before project sanction)

Specificities of on site construction

- Mainly a logistics problem
  - Access routes and traffic
  - Sufficient area to store and pre-assemble parts and equipment
- Timely delivery of construction drawings
- Timely delivery of equipment
- Management of a large work force
  - Accommodation on site
  - Access to the work front
- Planning of heavy equipment installation

Construction execution plan highlights

- Occupational Health & Safety Plan, Security Plan
- Organization, Management plan and procedures
- Accommodation, Camps, site offices, TCF facilities, Accesses & Traffic
- Construction methods, heavy-lifts, pre-fabrication
- Planning and Project Control
- Materials Management
- Logistics
- Contracts Administration; Changes Management
- Field Engineering
- Quality Control
- Hand-over to commissioning
- Lessons Learned

Construction execution plan highlights

Specifcities of offshore projects

- Offshore site access
- Maximal weight acceptable for lift
- Acceptable alternate to heavy lift
- Coordination with local fabrication yard
- Load out procedures
- Transportation procedures
- Site installation and hook-up procedures
- Offshore pipelines connection/tie-in
- Offshore pipeline laying constraint; shore approach guidelines…
- Pipeline construction main procedures
- Safety procedures

Construction contractual approach

- **Key objective: select fabrication/construction contractors that will ensure a competitive delivery of the project fabrication/construction**
- **Surveys of potential contractors**
- **Pre-qualification inquiries to prepare a qualified Subcontractors Master List based on**
  - Interest in the Project
  - Qualification for the works
  - Availability of resources personnel & construction equipment for the Project or for some of the project packages
- **Competitive bidding among qualified contractors, through a formal tendering procedure allowing**
  - Acceptance of contract conditions
  - Understanding of the scope
  - Competitive prices

Contracting strategy for offshore facilities

- **Offshore FPUs, FPSO Topsides, hull, and Offshore Platforms Topsides are usually be fabricated at yards, each being a work package.**
- **For an FPSO or a Float–over platform, for example, the strategy may involve competitive bidding by Consortia or Joint Ventures including:**
  - An EPC Contractor specialized in offshore for detail engineering, procurement and fabrication supervision, hook up and commissioning supervision.
  - A Yard for part of the procurement, fabrication, load-out of the hull or jacket and topsides.
  - An ocean transportation vessels Company for transportation and mating.
- **Or both above Contractors may be independently selected by Company after competitive bidding**

Contracting strategy for offshore facilities

- **For Offshore Field Development Project including several platforms and/or FPUS and/or FPSOs, the strategy will be developed considering a work package for each, depending upon the type of fabrication works required for the support or hull, topsides and T&I requirements.**

- **If the Field Development includes offshore, onshore, pipelines facilities, the strategy will be developed accordingly for the onshore part and the offshore part.**

Construction/fabrication strategy

- **The Project construction/fabrication activities are split into work packages, generally according to the project WBS:**
  - By Plants, by areas, Process Units, Offsites
  - And then by trades
- **And Inquiry packages are prepared with BOQ and scope for each work package**
- **This allows possibility to group several packages after evaluation of the offers**
- **It may be necessary to find a trade-off between:**
  - To secure enough contractors resources to provide reliable execution of the Project
  - But also to limit interfaces, and minimize the number of contractors, easier to manage and less costly
- **The above applies for onshore facilities stick-built or modularized**

Construction/fabrication contracts price schedule contracts

- **Price schedule or unit rates contracts: extensively used for onshore LSTK projects:**
  - Direct cost: unit price for each item of a detailed price schedule: BOQs (Bill Of Quantities)
  - Plus lump sum for indirect costs, fixed if quantities remain within a range (e.g. +- 20%)
  - The subcontractor guarantees a progress curve and completion dates

- **Flexibility advantage as**
  - Quantities cannot be known exactly until detail engineering is completed
  - The subcontractor can progress as long as work front is available, even if there are some delays for some activities of the Level II work construction schedule

Construction/fabrication contracts unit rates contracts

- **The contract structure is prepared with a Master Subcontracting Package (MSP) and specifics are added for each contract type; e.g., typically:**
  - Site preparation
  - Piling, Civil works, U/G piping, roads, Buildings (independent or together)
  - Structures fabrication
  - Piping pre-fabrication
  - Mechanical erection (equipment, piping, structures)
  - Electrical works
  - Instrumentation works …
  - Insulation, Painting (independent or together)

Benchmarks for construction ratios

Base: Europe

Peak Labor

- Average Load = Total Craft Man-months/Duration in months
- Peak Load = 8/5 x Average Load

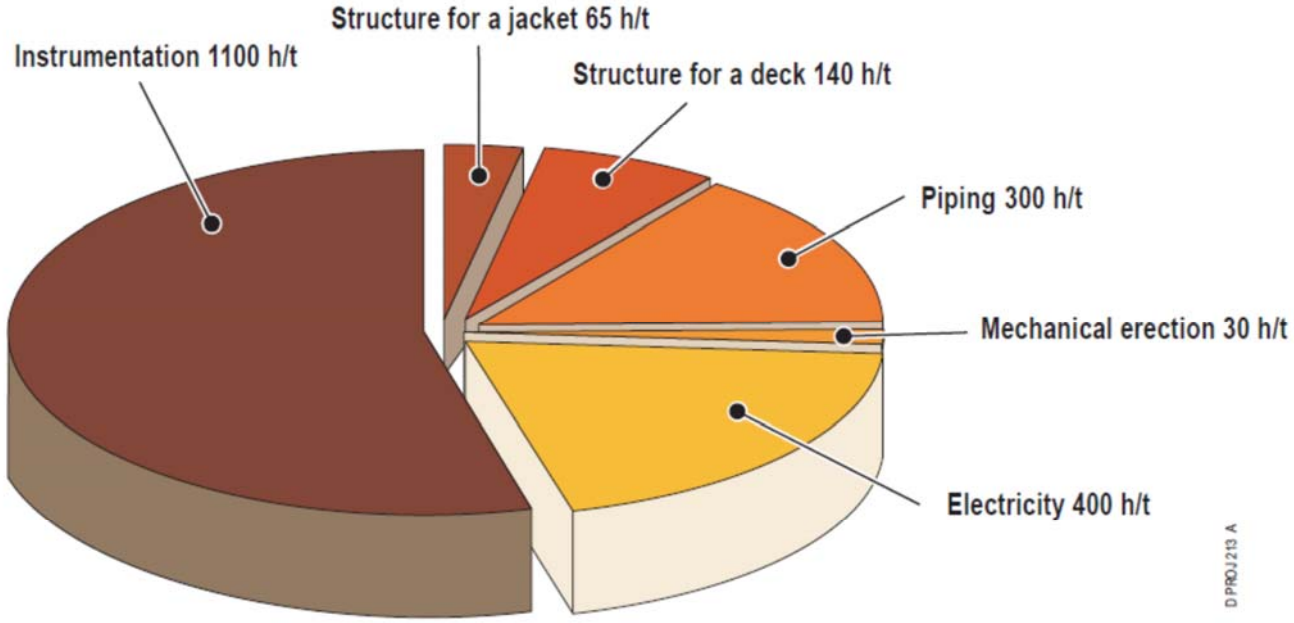
Construction Complexity

- Only applicable for process and utility areas
  - Simple Unit (e.g. Gas unit) — 40 - 55 manhours/m²
  - Average Unit (modules) — 60 - 75 manhours/m²
  - Complex Unit — 80 - 110 manhours/m²
    (e.g. Integrated deck, large modules)

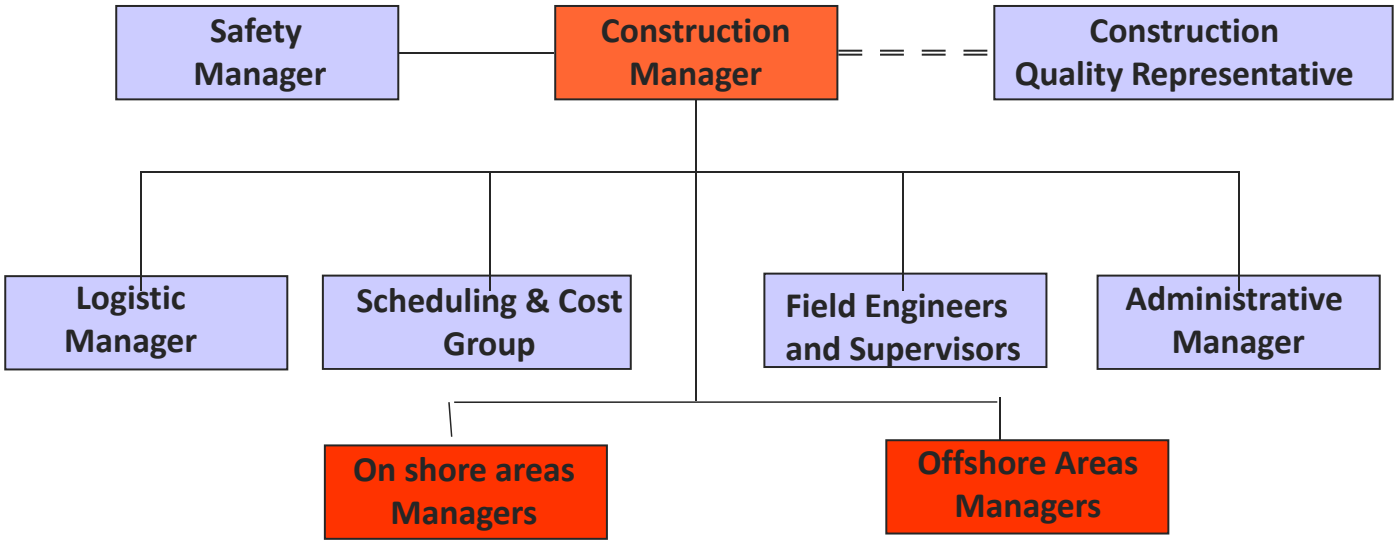
Labor Density

- Tied to above complexity data (m2 useful area)
  - Simple Unit — 14 - 18 m²/man
  - Average Unit — 17 - 25 m²/man
  - Complex Unit — 23 - 30 m²/man

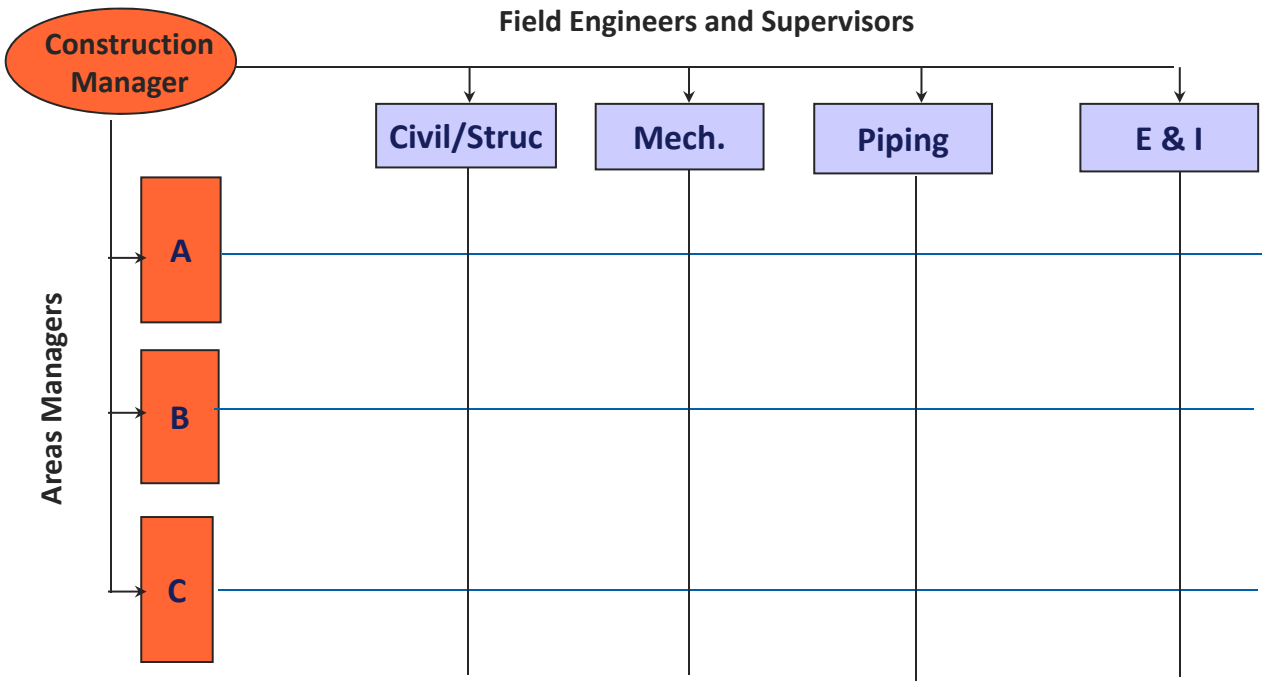
Benchmarks for construction ratios



Construction organization principles



Construction organization principles



Company, main contractor, construction sub-contractors typical roles

KEY ITEMS	COMPANY MGT TEAM	MAIN CONTROL. MGT TEAM	CONSTRUCT. SUB CONTRACTORS
SITE HSE PERFORMANCE	CHECKS	MANAGES	PERFORMS
CONSTRUCT. MGT PROCEDURES	REVIEWS / APPROVES	PREPARES	PREPARES for its scope / responsibility
FABRICATION / CONSTRUCTION EXECUTION	FOLLOWS / REVIEWS	MANAGES / INSPECTS	PERFORMS
CONSTRUCTION DOCUMENTS	REVIEWS / APPROVES	PREPARES	PREPARES for its scope / responsibility
CONSTRUCTION PROGRESS	CHECKS & APPROVES (for payments)	CHECKS QUANTITIES & CONSOLIDATES PROGRESS; APPROVES for payments;	PREPARES
CONSTRUCTION LABOUR RESOURCES	CHECKS	CHECKS PLANNED MOB.	MOBILIZES
MATERIALS & EQUIPMENT	CHECKS LOCAL PURCHASES	SUPPLY EQUIPMENT & BULKS. MANAGES WAREHOUSE	SUPPLY CONSTRUCT. MATERIALS.
CONSTRUCTION MATERIALS	REVIEWS	INSPECTS	SUPPLY CERTIFICATES
CONSTRUCTION EQUIPMENT	CHECKS	CHECKS	SUPPLY & SUPPLY CERTIFICATES
KEY CONSTRUCTION OPERATIONS METHOD STATEMENTS	REVIEWS / APPROVES	REVIEWS / APPROVES	PREPARES for its scope / responsibility
KEY CONSTRUCTION OPERATIONS	WITNESSES	CONTROLS	PERFORMS
QC DOCUMENTS	REVIEWS / APPROVES	REVIEWS / APPROVES or PREPARES	PREPARES for its scope / responsibility
HAND OVER DOCUMENTS	REVIEWS / APPROVES	PREPARES	PREPARES for its scope / responsibility
SOLVING OF CONSTRUCT. ISSUES	PARTICIPATES	MANAGES	PERFORMS

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Note: In case of a General Construction or Fabrication Contractor (nominated or in Consortium), Main Contractor role is reduced

Construction HSE plan highlights

- Subcontractors' Selection Criteria
- Company Management Commitment
- Professional Competence and Qualification of Labor
- Employee Training and Participation
- Safety Communication, Safety Information, Safety Meetings
- Work Preparation and Organization
- Risk Evaluation, Job Safety Analysis (part of Work Statements)
- Accidents/Near Miss Incidents Investigation and Reporting
- Hunt Down and Correct Unsafe Conditions and Behaviours
- Results Measurement, Deviations Analysis, Corrective Actions
- Field and System Audits, Continuous Improvement System
- Emergency Planning and Response
- Permit To Work system for work in existing facilities
- Safety awareness is at site and at facilities used to work at site

Material management system

- **Major EPC Contractors have implemented an integrated Material Management System which incorporates all data on commodities requisitioned, bill of bulks materials and their procurement status.**
- **Purchasing, expediting, inspection, shipping, receiving and site storage and handling information is loaded in the system, successively by engineering, procurement (expediting) and construction.**
- **The system allows individual tracking of bulks items from MTOs to the site**
- **At Site it allows to:**
  - Continuously update the material warehouse inventory upon material receipts.
  - Issue OS&D reports.
  - Know the status of material deliveries and check or forecast availability of material for pre-fabrication or erection in order to plan the fabrication/construction or expedite lacking items (this can also be done at Home Office).

Temporary construction facilities plan (1/2)

- **A Plan for timely and adequate development of TCF is essential, including drawings for these facilities**
  - Company, Contractor and Subcontractors offices with IT/telecom for easy communications
  - First Aid/Medical Aid Facilities
  - Main Warehouse (managed by Main Contractor)
  - Construction Contractors Warehouse/Consumables Store
  - Main Lay down Area
  - Concrete Batching Plant
  - Concrete pre-casting yard

Temporary construction facilities plan (2/2)

- Fabrication Facilities Piping prefab (spools, CS –SS); steel supports
- Spool Lay-down area (piping, steel...)
- Dress-up area, Air coolers assembly area
- Plant & Vehicles maintenance facilities
- Test laboratories/calibration facilities
- Painting: blasting shop
- Hot insulation & cold insulation shops
- Areas for specific contractors (API tanks, Refrigerated Tanks…)
- Access roads & gates
- May reach up to 100 hectares for Mega Projects…

Equipment delivery/erection

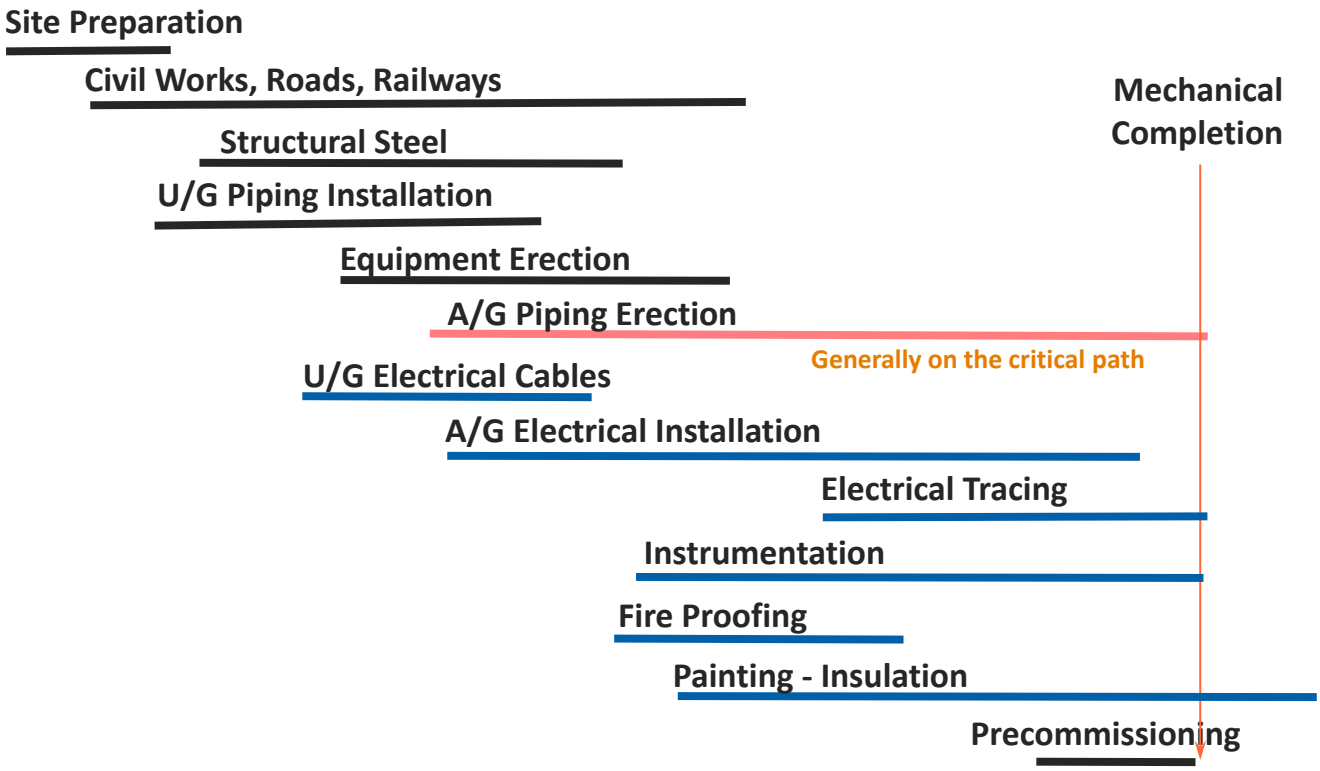
- Minimize transportation cost/erection cost
- Balance large cranage requirement cost versus advantage of direct delivery/erection onto foundations
- Delivery of abnormal loads (heavy, large):
  - Ocean jumbo dedicated ships (RO/RO or LO/LO) to nearest port or private MOF
  - On-land Transportation studies to site foundation
  - Rigging study for erection

Construction management

- Fabrication and construction activities
- **Planning Construction activities**
- Performing Construction activities
- Controlling Construction activities

Typical construction schedule

Case of an onshore project



Six conditions to start construction

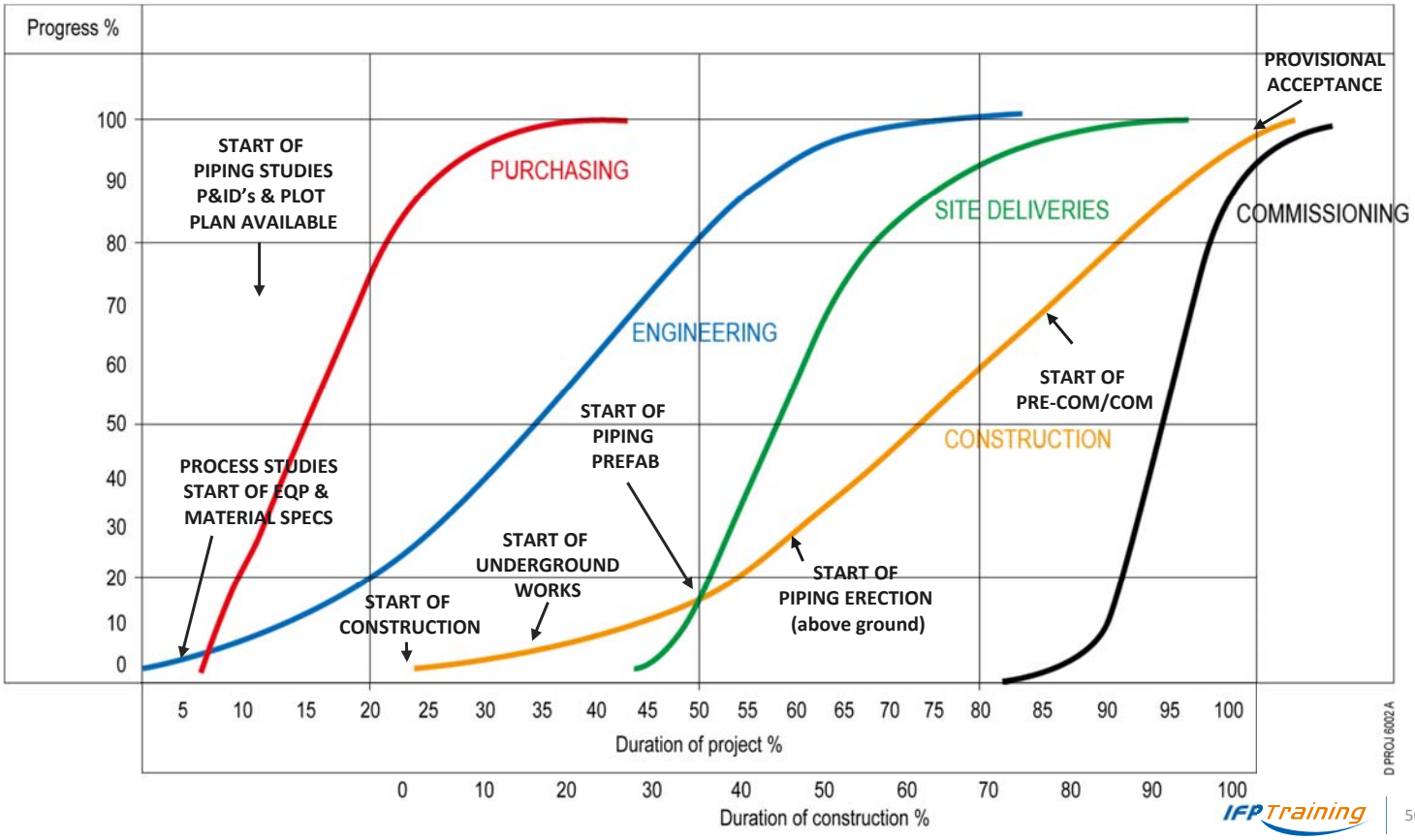
- **Deliverables**
  - Approved For Construction Drawings and specifications, procedures
- **Equipment**
  - Rotating machines, separators, Pumps…
- **Materials**
  - Structure, piping cables, cement…
- **Tools**
  - Cranes, welding tools, control apparatus…
- **Consumables**
  - Electric power, water, fuel, welding rods…
- **Manpower**
  - Resources Mobilized

Construction schedule drivers

- **Engineering documents delivery**
- **Equipment and bulks delivery**
- **Homogeneous progress by trades consistent with planned progress**
- **Work front availability**
- **Recovery measures in case of schedule slippage**
- **Then progress/completion by systems to transfer the units to commissioning per pre-com/com schedule**

Anticipating project duration

Typical progress curves and milestones



Construction management

- **Fabrication and construction activities**
- **Planning Construction activities**
- **Perform Construction activities**
  - **Site preparation**
  - **Discipline activities**
  - **Pre-commissioning**
- **Control and monitor Construction activities**

Site preparation

- Some sites are quite difficult, by the sea, but rocky, with quite sloppy grounds (e.g. from 0 to 90 m elevation…).
- 3 to 30 MM m^3 common for large projects.
- Blasting MM of m^3 on rocky sites is required.
- Excavation of complete process areas and backfilling with controlled materials when soil is too rocky.
- For shore developments, possibility of reclamation over sea
- Site preparation may take up to 1 or 2 years and a detailed study may be required at early FEED time.

Site preparation in a rocky environment



Yard fabrication

Examples of SPMT load-out







Discipline activities

- **Civil (Concrete/Steel) & Buildings**
  - Phase-by-phase and discipline-by-discipline
- **Mechanical**
  - Release to piping
- **Piping prefabrication and erection**
  - Release after (hydro)test
- **Electricity & Instrumentation**
  - Release to pre-commissioning
- **Paint & Insulation**
  - Release to start-up

Construction management

Fabrication and construction activities

Planning Construction activities

Perform Construction activities

Control and monitor Construction activities

- **Progress measurement**
- **Particular aspects linked to Local Content**
- **Quality Control**

Monitoring of construction

- **Progress Measurement**
  - Follow up Monthly/Weekly Progress by Work Quantities/Man-hours
- **Productivity Analysis**
- **Man-hours Expenditure**
  - Follow-up Monthly/Weekly Man-hours per trade
- **Trending and Forecasting**
  - Compare earned man-hours per Work Quantities
  - Look for Trends, Forecast

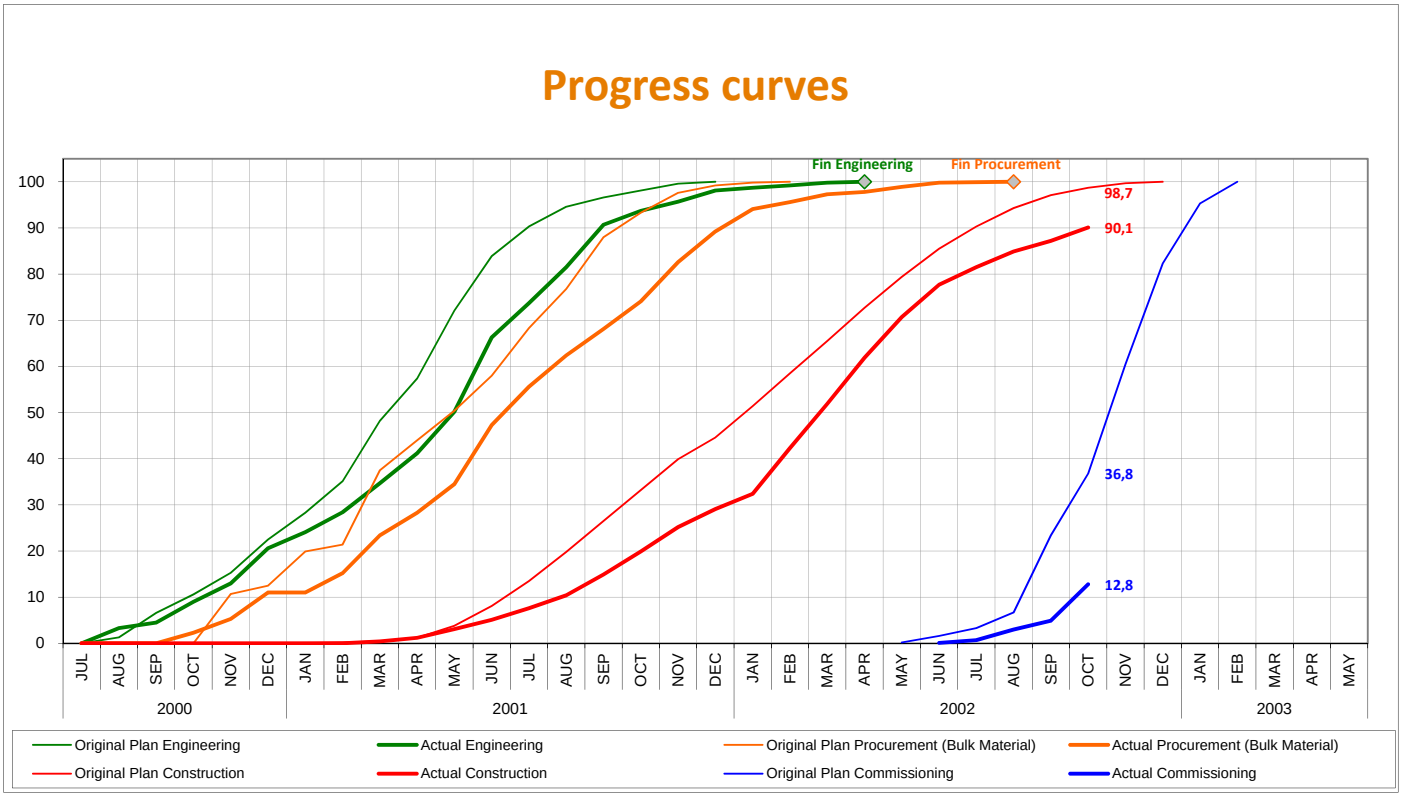
Definition of manhours categories

- **Direct productive manhours**
  - Hours spent by the work force to perform the measurable scope of work
  - They are used to estimate the resources and to monitor the progress
  - Direct man-hours are estimated using the industry/contractors ratio related to the type and conditions of work to be performed
- **Direct unproductive manhours**
  - Hours spent in support of the work force performing the measurable work, i.e. material handling, scaffolding, construction equipment maintenance, site cleaning
- **Non productive manhours**
  - Hours spent by the work force not directly linked to the physical advancement of the work i.e. which result from work interruptions, stand by, waiting for material, interface problems, waiting on work permits, accidents, sickness. Local site travel and meal time are also considered as non productive
  - Non technical hours related to management: project management team, supervisors, inspectors.

Man-hours and progress definitions

- **Costs and Progress definitions:**
  - **Earned costs**
    - **They represent the costs authorized in the budget to complete or partially complete an activity**
  - **Actual/consumed or spent costs**
    - **They represent the actual man-hours expended to complete or partially complete an activity**
- **Progress measurement**
  - **Physical progress= actual progress/planned progress**
  - **"Productivity": earned costs/actual costs**
    - **A factor smaller than 1 demonstrates a bad productivity**
    - **A factor higher than 1 demonstrates a good productivity.**
- **Depending on companies, productivity may be calculated on man-hours and not on costs, PMI proposes to follow values**

Monitoring of construction: delay on engineering & procurement results in delay in construction



Implementation of the Local Content plan

- **Ensure consistency between contractors commitments and project expectations in terms of LC (traceability)**
- **Liaise with contractors & their sub-contractors to monitor their performance and ability to deliver LC**
  - Supervise and facilitate the input of all stakeholders related to LC scope and execution
- **Facilitate resolution of difficulties associated to LC delivery**
  - Build recovery plan, second man-power to assist sub-contractors or contractors in project management, etc.
- **Monitor contractor/vendor training programs & efficiency of transfer of know-how**

Local content – Measurement and control

- **Local content accounting procedure specific to the project country**
  - Local content metrics
    - Tonnage
    - Man-hours for local work force
    - Man-hours for expatriate work force in The Host Country
    - Other parameters about people: training, transfer of know-how, monitoring of local employment, etc. (if applicable)
    - Technical difficulty level (1 to 4)
      - Local Content Indicators on technical and criticality level for fabrication, assembly, actions and services provided to the project will help to understand the effectiveness of the industrial skill development and transfer to know how.
    - Production site
    - Project cost (percentage of the package cost)
  - Record deviations from the agreed plan and explain reasons for those deviations

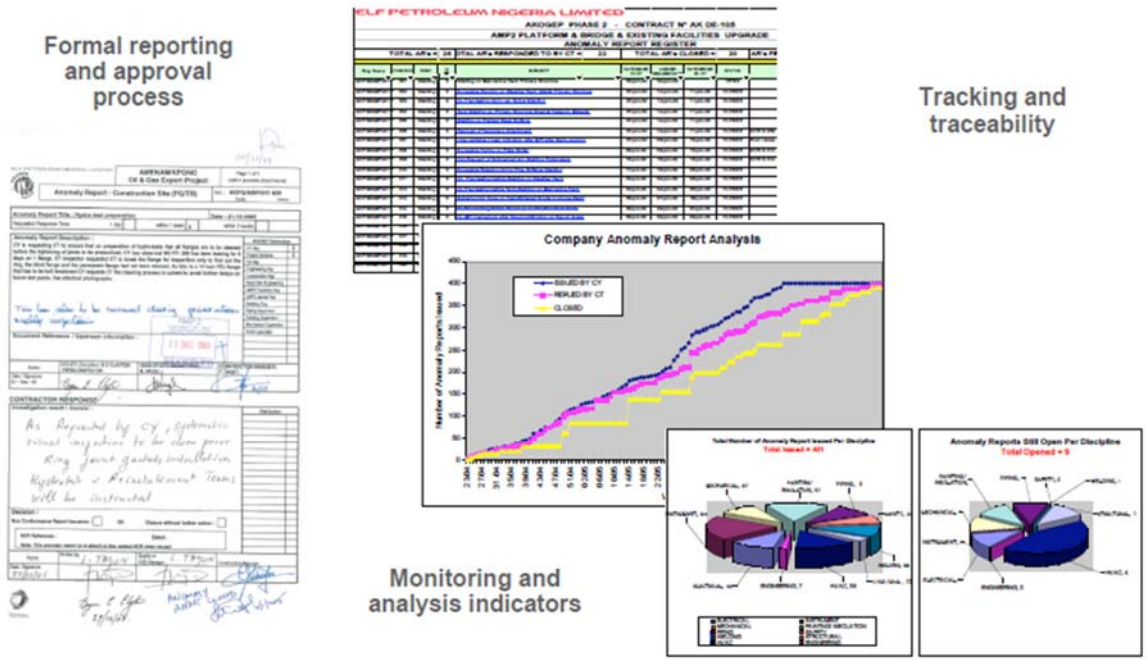
Local Content metrics for construction activities

- **Tonnages (fabrication or integration of structure/modules)**
  - Tenderers evaluation
- **Local work force**
  - Man hours by category (unskilled, medium skilled, management)
  - Associated cost
  - Training (even abroad)
- **Man hours for expatriate work force in the Host Country**
  - Transfer of know-how
  - Training of nationals
  - … or no expatriates, or a very few minimum
- **Technical difficulty level (below)**
  - Effectiveness of skill development & transfer of know-how
- **Construction site (LC impact)**
- **Project cost**
  - Aggregation of LC % of package cost

Construction quality control

- **Quality Control Plans are prepared to check construction quality by inspection and tests, as construction progresses and works are completed.**
- **Quality is controlled by the Quality Control team which includes:**
  - Piping & mechanical inspectors
  - Civil works inspectors
  - Welding inspectors
  - E& I inspectors
- **Non-conformance reports are prepared when works are not in conformity with specifications, drawings or construction specifications.**
- **Site Quality Control may also be controlled by an Independent Third Party, for instance for welding inspection.**

Non-conformance reporting



Construction management

- Different construction strategies can be envisaged: stick built vs modularization
- A number of conditions have to be met to start the construction efficiently (availability of drawings and equipment)
- Physical progress and productivity are the two parameters to be evaluated jointly to monitor efficiency of the construction operations
- Personnel safety is critical at that stage (prevention plan and resources to be in place)
- Special follow-up of local-content construction activities should be made to ensure that the quantities achieved effectively correspond to the contractual commitment



Pre commissioning and Commissioning

Foreword

- **Main objective**
  - Successful transfer of responsibilities to the operator at the end of the project

- **Main tools and means**
  - Methodologies and IT tools to be used to ensure efficient pre commissioning and commissioning

About Commissioning management
Planning commissioning
Methodology
Tools and techniques
Organization and contracting

Definitions

- **PRE COMMISSIONING, or mechanical completion (non-energized):**
  - Visual inspection of equipment (Power Generation, motors, cables...).
  - Quality of installation.
  - Compliance with Project drawings and specifications.
  - « Cold testing »: calibration of instruments, machinery alignment, setting of safety valves, pressure testing of piping... (De-energized tests).
  - Pipes and vessels air or water flushing and cleaning.

- **COMMISSIONING: all the test activities carried out on a new plant, between the end of construction and the production start-up, which energize the systems.**
  - Electrical motors uncoupled runs, instrument loops tests, electrical breakers operation...
  - Running-in and on-line tests of plant utilities, and main process equipment in closed loop (wherever applicable).
  - Piping drying out and leak testing, inerting or loading of various chemicals.
  - Tests of all safety systems (gas detection, fire water…).

Completion activities and milestones

PHASE	ACTIVITIES	MILESTONE
PRE-COMMISSIONING	CONFORMITY CHECKS STATIC TESTING FLUSHING & CLEANING	READY FOR COMMISSIONING
COMMISSIONING	ENERGIZATION DYNAMIC TESTS EQUIPMENT RUNNING-IN START-UP OF UTILITIES TESTS OF SAFETY SYSTEMS	READY FOR START-UP (RFSU)
START-UP	OIL & GAS IN BRINGING PLANT ON LINE PERFORMANCE TESTS	PROVISIONAL ACCEPTANCE

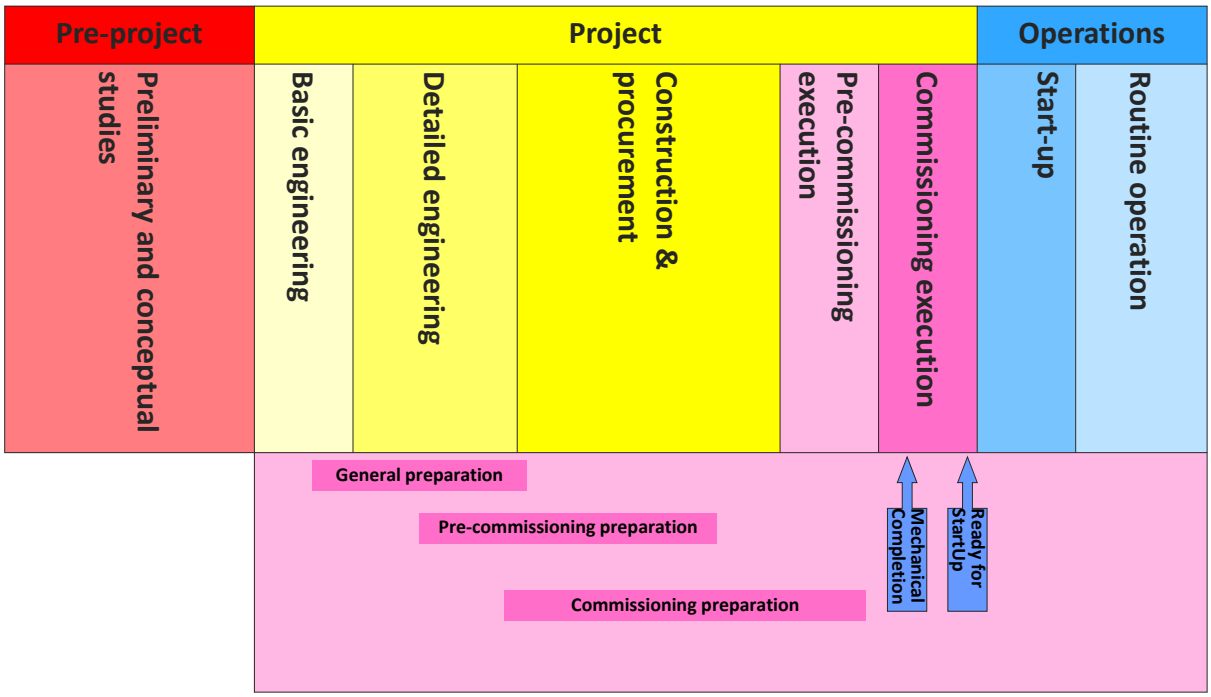
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Commissioning management

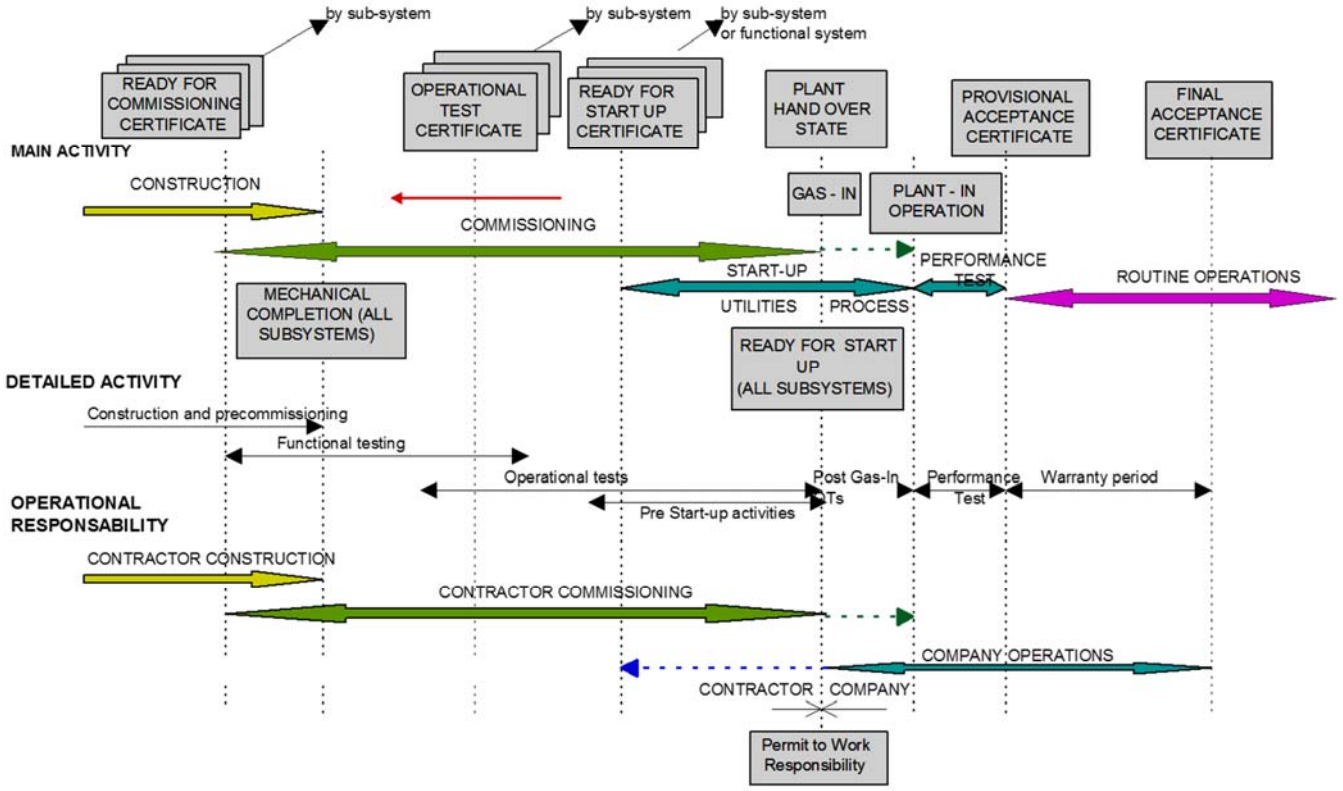
- About Commissioning management
- **Planning commissioning**
- Methodology
- Tools and techniques
- Organization and contracting

Completion activities preparation

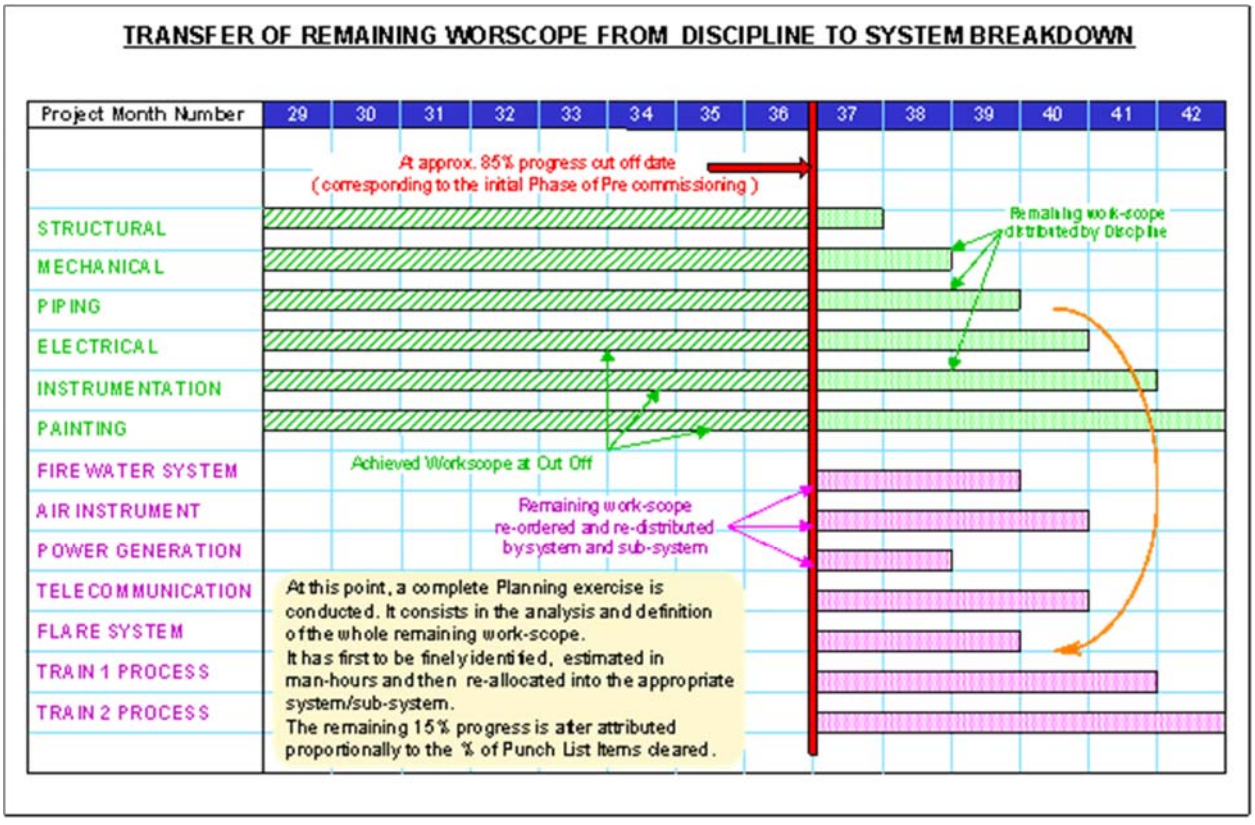
Project phase and completion activities



Overall Sequence



Interface between construction and commissioning

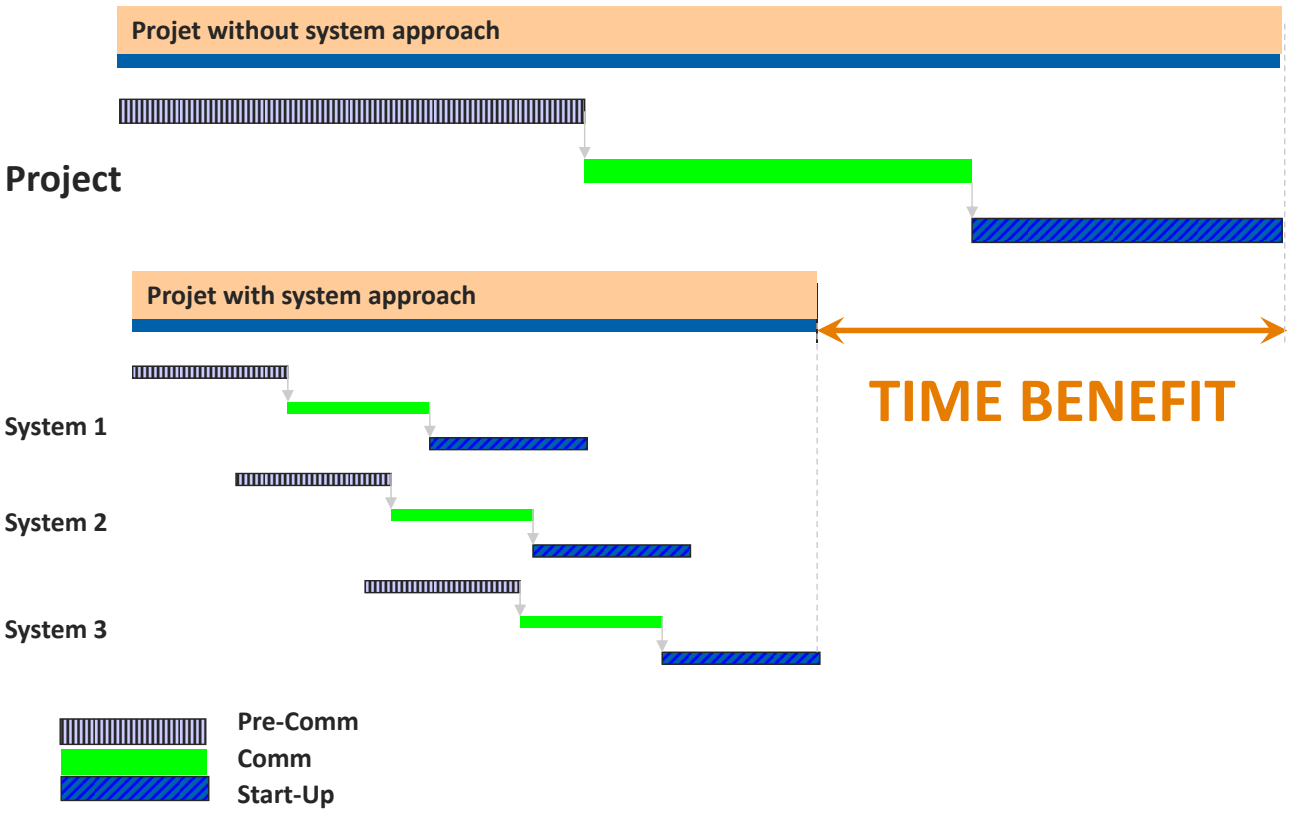


From Trade to System approach

- **CONSTRUCTION: organized and split by Trades, disciplines (Civil work, structural, piping, electricity, mechanical…).**

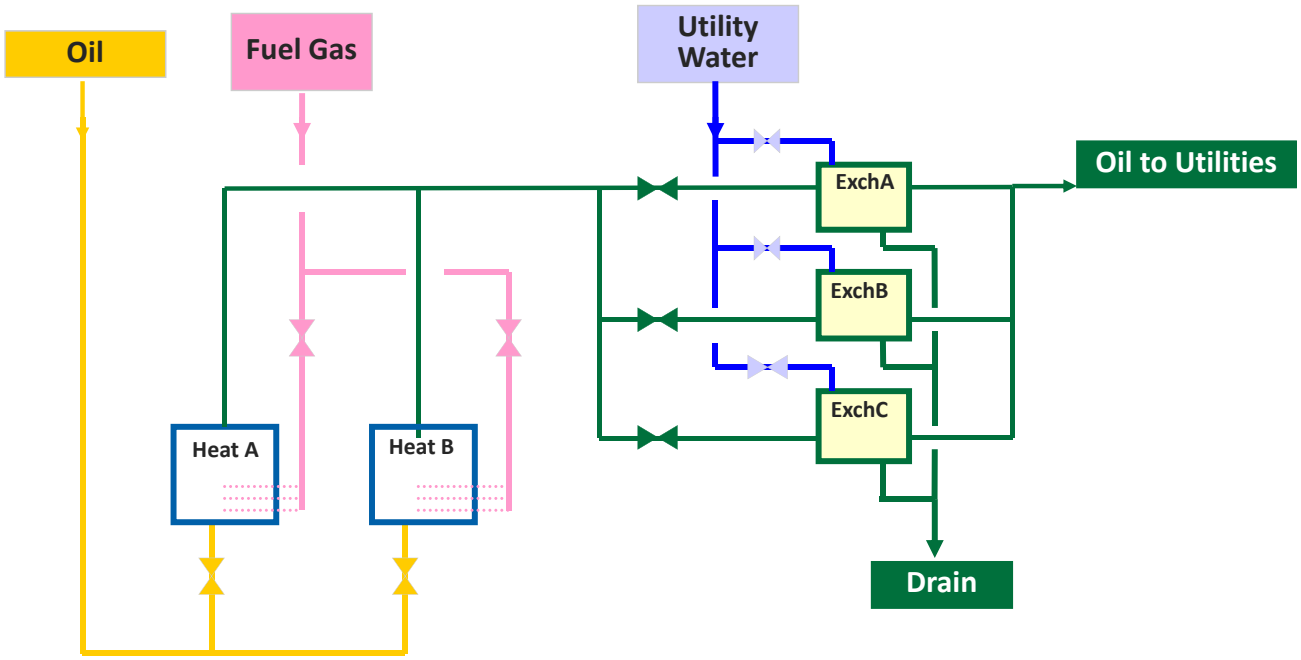
- **Commissioning Activities & Start-up: organized by SYSTEM (Functions)**
- **A system is a part of an Installation (built by various trades) that performs a given operational function such as:**
  - Safety system
  - Instrument air
  - Fire water
  - Oil separation

System approach



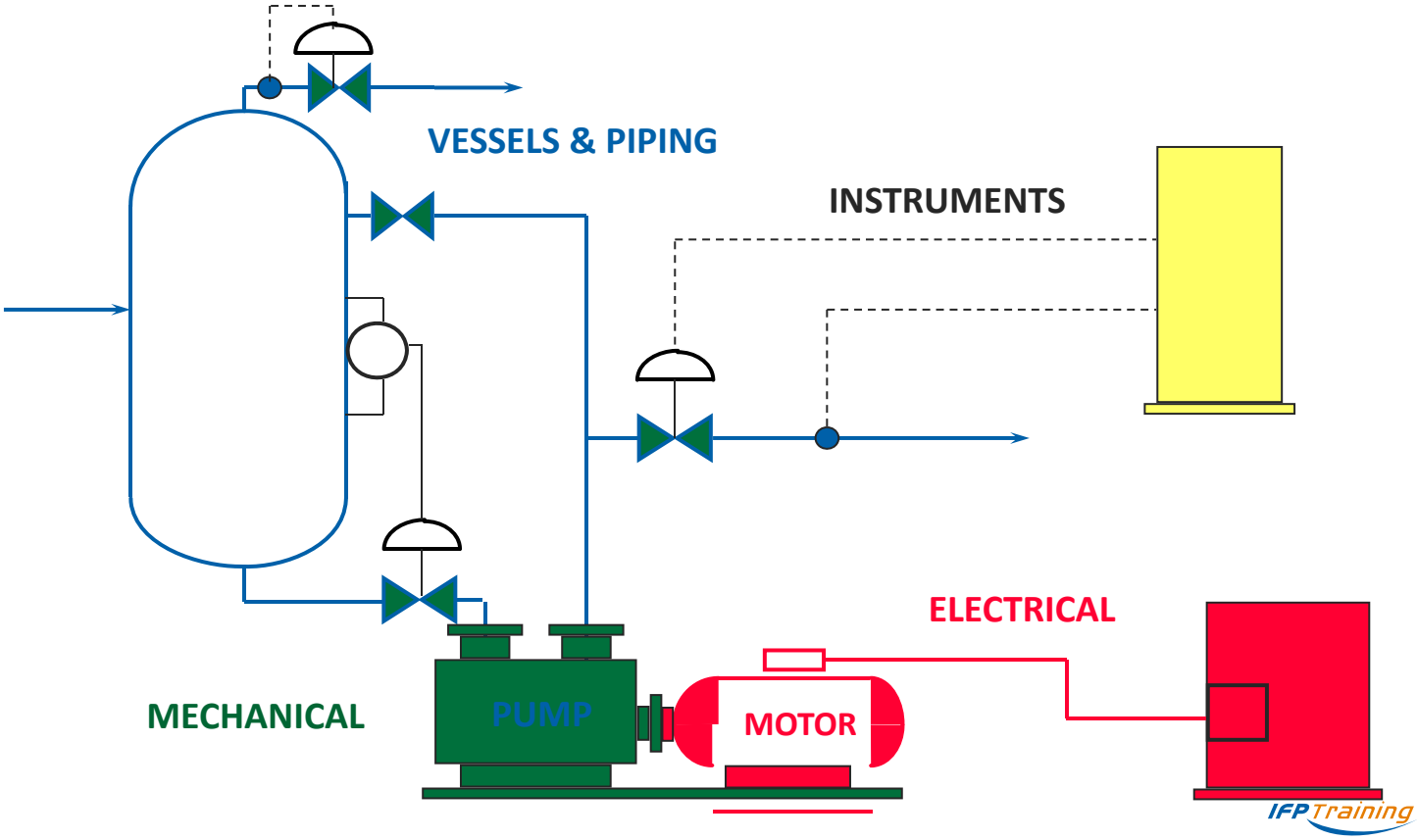
System approach

Example of sub system breakdown



System approach

Sub system disciplines



Example: number of systems and sub-systems

SYSTEM		55				
SUBSYSTEM		Hull	Topsides		UFL	TOTAL
		345	401		28	774
		Hull	Onshore	Offshore	UFL	TOTAL
Precomm.	in qty	33223	78053	1513	1347	114136
Comm.	in qty	5508	17271	3615	71	26465
	in MH	156192	49669	72513	558	278932
Logic software modifications		# 1000 (for Hull+ Topside + Subsea) number doesn't include graphic mods				
Punch List Items in qty		Hull	12822			
		Topsides	25479			
		UFL	128			
		TOTAL	38429			

Commissioning management

- About Commissioning management
- Planning commissioning
- Methodology
  - **Pre commissioning methodology**
  - **Commissioning methodology**
- Tools and techniques
- Organization and contracting

Pre-commissioning

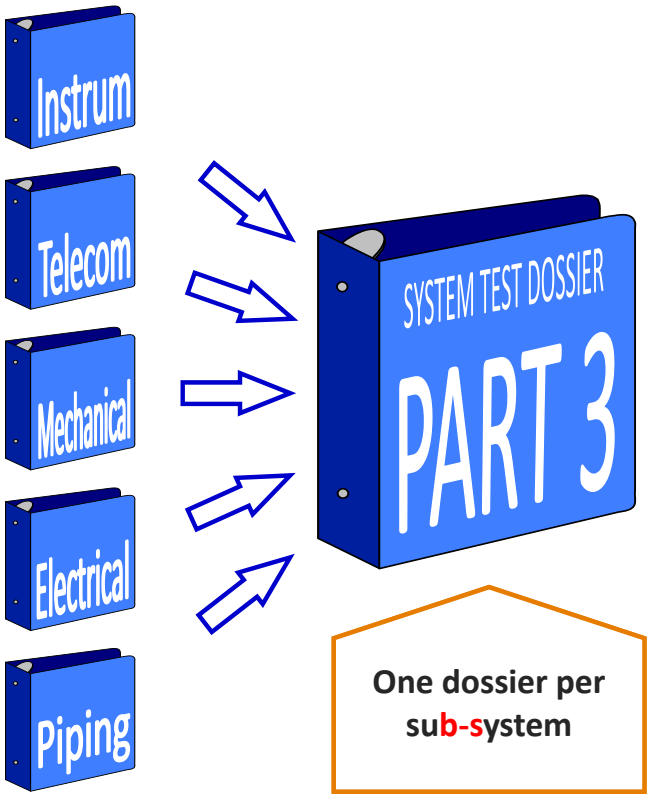
- **Pre-commissioning is the last phase of Construction (to be maximized onshore for offshore project):**
  - Piping hydrotests
  - Test of Electrical Installation
  - Test of Instrument Control Loops Continuity Tests
  - Align Rotating Equipment
  - Punch Lists
    - Prepared by both Construction and Operation Teams
    - Categorize Punch List Items
      - A = Items to be completed before Mechanical Completion
      - B = Items to be completed before Start-Up
      - C = Items which can be completed post Start-Up
      - D = Nice to have items, but not part of the scope,
    - Items to be assessed later on their own merit by Operation

Pre-commissioning methodology

TASK	DISCIPLINE	NUMBER	SUPPORT DOCUMENT
Conformity Checks	All	- 1 per item of equipment (Field) - 1 per package	- 1 Check List per type of equipment & subsystem(Field) - 1 Check List per package - 1 List of checks in the Status Index
Static Tests	All	- 1 test per specified item (Field) - 1 test per safety item (Package)	- 1 Test Sheet per test - List of tests in the Status Index
Flushing & Cleaning	Process	- 1 per subsystem or Network or Test Pack	- Specific procedure & report

Sequence documentation and dossiers

Pre commissioning dossier



Combined RFC Certificate



SINCOR PROJECT

READY FOR COMMISSIONING CERTIFICATE

R.F.C. No: _____

EPC or EPCC CONTRACTOR LOGO

SUB-SYSTEM NO.:

SUB-SYSTEM DESCRIPTION:

Pursuant to sub-Article 10.1.1 of the AGREEMENT, COMPANY hereby certifies that the following Functional Systems of the PLANT are mechanically complete and have been tested and pre commissioned in accordance with the requirements of the CONTRACT and are therefore in readiness for commencement of the associated commissioning activities, in accordance with the requirements of the CONTRACT, with the exception of the outstanding items listed upon the attached Punch List, it being understood that should CONTRACTOR fail to complete all of the outstanding items in respect of a System within the respective period stated upon the Punch List the present Certificate shall be null and void in respect of such Systems.

DISCIPLINE	PIPING	MECHANICAL	ELECTRICAL	INSTRUMENT	TELECOM
PUNCH LIST SHTS / ITEMS	No of Sheets: No of Items: Date:	No of Sheets: No of Items: Date:	No of Sheets: No of Items: Date:	No of Sheets: No of Items: Date:	No of Sheets: No of Items: Date:
CONTRACTOR'S CONSTRUCTION (DATE AND SIGNATURE)	Signature: Date:	Signature: Date:	Signature: Date:	Signature: Date:	Signature: Date:
CONTRACTOR'S COMMISSIONING (DATE AND SIGNATURE)	Signature: Date:	Signature: Date:	Signature: Date:	Signature: Date:	Signature: Date:
SINCOR DISCIPLINE REPRESENTATIVE ACKNOWLEDGEMENT	Signature: Date:	Signature: Date:	Signature: Date:	Signature: Date:	Signature: Date:

CONTRACTOR'S CONSTRUCTION MANAGER	CONTRACTOR'S COMMISSIONING MANAGER	SINCOR COMMISSIONING SITE LEADER
Name:	Name:	Name:
Date :	Date:	Date:
Signature:	Signature:	Signature:

Issuance of this READY FOR COMMISSIONING CERTIFICATE shall not relieve CONTRACTOR from his warranty obligations and other provisions of the CONTRACT which expressly or by their nature survive the said certificate

Commissioning methodology

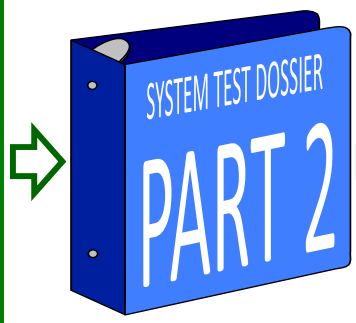
TASK	DISCIPLINE	NUMBER	SUPPORT DOCUMENT
Preliminary Checks	All	- 1 per subsystem - 1 per package	- 1 task report form per subsystem + punch list items in Precomm. dossier
Functional Tests	Electrical Instruments Telecommunication	- 1 test per Basic Function	- 1 Functional Test Sheet List of tests in Technical Data Base
Operational Tests	Test:multi-discipline	- 1 per subsystem or Network	- 1 operational Test Procedure by Subsystem, specific to the installation
Pre-Start up Activities	Process	- 1 per subsystem,or level of pressure, or main circuit	- Leak test, Inerting... reports, specific to the Installation

Sequence documentation and dossiers

Commissioning dossier

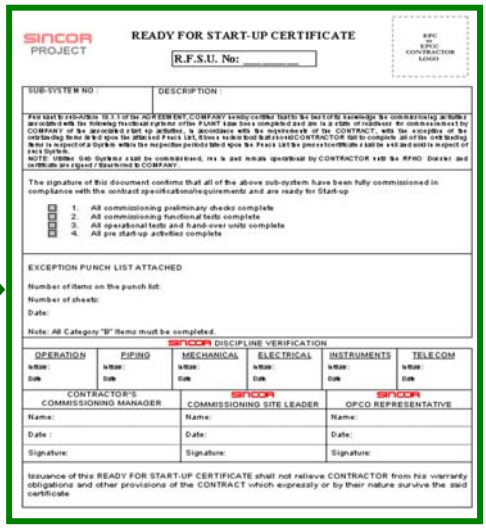
RFSU Dossier Index

1. SUB-SYSTEM DEFINITION:
   - 1.1 SUB-SYSTEM DESCRIPTION / LIMITS
   - 1.2 SUB-SYSTEM TECHNICAL DATABASE LISTING
2. READY FOR START-UP DOCUMENTATION:
   - 2.1 READY FOR START-UP CERTIFICATE
   - 2.2 "EXCEPTION PUNCH LISTS (PER DISCIPLINE)
   - 2.3 "AS-COMMISSIONED" P&ID's / SLD's / D&ID's / C&E's
   - 2.4 "AS-COMMISSIONED" BLIND LIST
   - 2.5 PRESERVATION RECORDS
   - 2.6 KEY LIST REGISTERS
3. PRE START-UP ACTIVITIES:
   - 3.1 LUBRICATION SCHEDULE INDEX
   - 3.2 CHEMICAL LOADING & FIRST FILL RECORDS
   - 3.3 LEAK TEST / DRYING / INERTING / VACUUM TESTING RECORDS
   - 3.4 FINAL MECHANICAL / VESSEL INSPECTION CHECKS
   - 3.5 CHEMICAL CLEANING REPORTS & RECORDS
4. SITE / OPERATIONAL / ENERGIZATION PROCEDURES SAT / OTP /ETP / UAT / PAT:
   - 4.1 SITE / OPERATIONAL / ENERGIZATION TEST PROCEDURE INDEX (SAT /OTP / ETP / UAT / PAT)
   - 4.2 OPERATIONAL DEMONSTRATION TEST PROCEDURES (SAT / OTP / UAT / PAT)
   - 4.3 ENERGIZATION TEST PROCEDURES (ETP)
5. FUNCTIONAL TESTS & "AS-COMMISSIONED" DRAWINGS:
   - 5.1 ELECTRICAL TECHNICAL DATABASE & FUNCTIONAL TEST SHEETS
   - 5.2 ELECTRICAL "AS-COMMISSIONED" INTERCONNECTION DIAGRAMS
   - 5.3 INSTRUMENTATION TECHNICAL DATABASE & FUNCTIONAL TEST SHEETS
   - 5.4 INSTRUMENTATION "AS-COMMISSIONED" TROUBLE SHOOTING DIAGRAMS
   - 5.5 TELECOMMUNICATIONS DATABASE & FUNCTIONAL TEST SHEETS
   - 5.6 TELECOMMUNICATION "AS-COMMISSIONED" I.C.D / TSLD's
6. VENDORS:
   - 6.1 VENDOR PACKAGE SUMMARY INDEX
   - 6.2 VENDOR FAT's SITE REPORTS & DRAWINGS
   - 6.3 VENDOR SPARES & SPECIAL TOOLS LISTS
   - 6.4 VENDOR DATA / OPERATIONS / MAINTENANCE MANUALS
7. PRELIMINARY CHECKS:
   - 7.1 PRELIMINARY CHECKS (PER DISCIPLINE)
8. MODIFICATIONS:
   - 8.1 MODIFICATION APPROVALS & CONTROL SHEETS
9. SUPPORTING DOCUMENTS:
   - 9.1 OTHER SUPPORTING DOCUMENTS (AS APPLICABLE)



One dossier per sub-system

RFSU Certificate



SINCOR PROJECT

READY FOR START-UP CERTIFICATE

R.F.S.U. No: _____

SUB-SYSTEM NO : | DESCRIPTION :

The signature of this document confirms that all of the above sub-system have been fully commissioned in compliance with the contract specifications/requirements and are ready for Start-up

1. All commissioning preliminary checks complete
2. All commissioning functional tests complete
3. All operational tests and hand-over units complete
4. All pre start-up activities complete

EXCEPTION PUNCH LIST ATTACHED

Number of items on the punch list:
Number of sheets:
Date:

Note: All Category "B" items must be completed.

SINCOR DISCIPLINE VERIFICATION

OPERATION	PIPING	MECHANICAL	ELECTRICAL	INSTRUMENTS	TELECOM
Name: Date	Name: Date	Name: Date	Name: Date	Name: Date	Name: Date

CONTRACTOR'S COMMISSIONING MANAGER	SINCOR COMMISSIONING SITE LEADER	SINCOR OPCO REPRESENTATIVE
Name:	Name:	Name:
Date :	Date:	Date:
Signature:	Signature:	Signature:

Issuance of this READY FOR START-UP CERTIFICATE shall not relieve CONTRACTOR from his warranty obligations and other provisions of the CONTRACT which expressly or by their nature survive the said certificate

Sequence documentation and dossiers

Hand-over dossier





One dossier per hand over unit

RFHO Certificate



SINCOR PROJECT

READY FOR HAND-OVER CERTIFICATE

R.F.H.O. No: _____

HAND-OVER UNIT NUMBER : | DESCRIPTION :

SUB-SYSTEM No(s) :

ALL COMMISSIONING ACTIVITIES PERFORMED WITH ALL HAND-OVER UNITS COMPLETE & R.F.H.O.

The signature of this document confirms that all of the above sub-systems/systems/hand-over units have been fully commissioned in compliance with the contract requirements/specifications and are ready for hand-over:

1. All Respective RFC's & RFSU Dossiers accepted, signed and handed over to COMPANY.
2. All final documentation Handed over to COMPANY.
3. All Vendor Documentation Handed over to COMPANY.
4. All Spares, Special Tools, Keys, Operation/Maintenance Manuals, and As-Built as commissioned documentation have been handed-over to COMPANY.

EXCEPTION PUNCH LIST ATTACHED

Number of items on the punch list:
Number of sheets:
Date:

Note: All category "C" items must be completed.

FORMAL DATE AND TIME OF TRANSFER

DATE : _____ TIME _____

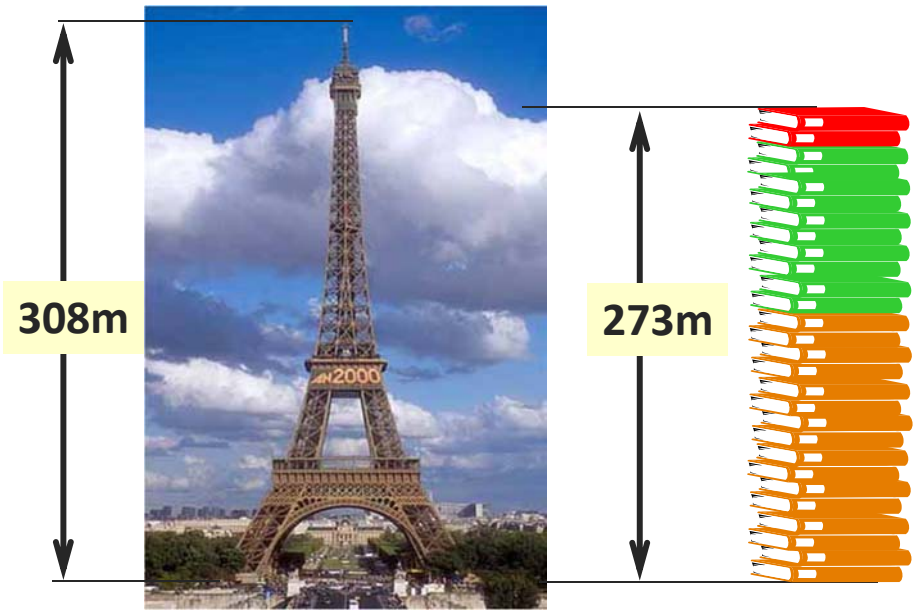
SINCOR COMMISSIONING SITE LEADER VERIFICATION	SINCOR OPCO REPRESENTATIVE VERIFICATION
Name:	Name:
Date:	Date:
Signature:	Signature:

CONTRACTOR'S COMMISSIONING MANAGER	SINCOR COMMISSIONING MANAGER	SINCOR OPCO MANAGER
Name:	Name:	Name:
Date :	Date:	Date:
Signature:	Signature:	Signature:

Issuance of this HAND-OVER CERTIFICATE shall not relieve CONTRACTOR from his warranty obligations and other provisions of the CONTRACT which expressly or by their nature survive the said certificate

Sequence documentation and dossiers

Overall dossiers

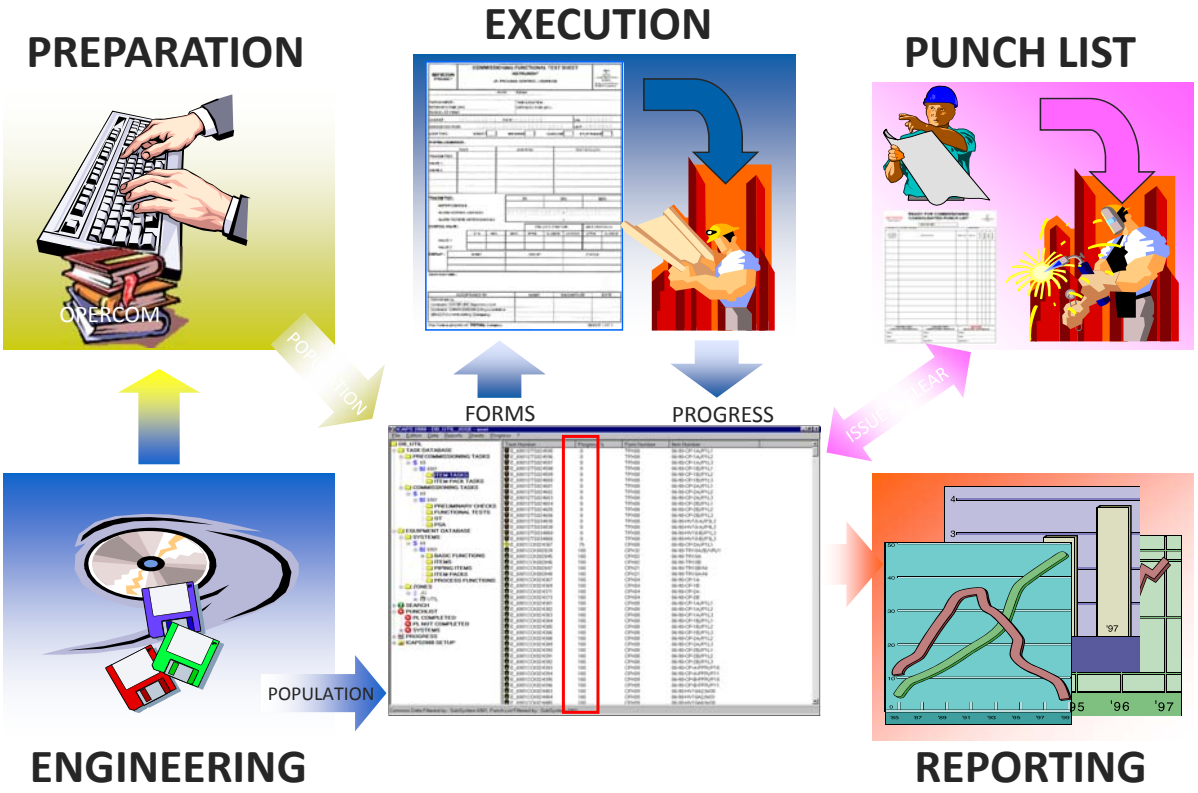


206	HOU Dossiers
849	RFSU Dossiers
891	RFC Dossiers
1,946	Dossiers

Commissioning management

- About Commissioning management
- Planning commissioning
- Methodology
  - Pre commissioning methodology
  - Commissioning methodology
- **Tools and techniques**
- Organization and contracting

Use of dedicated IT tools to carry out Commissioning



Commissioning management

- About Commissioning management
- Planning commissioning
- Methodology
- Tools and techniques
- **Organization and contracting**

Commissioning management

Key elements

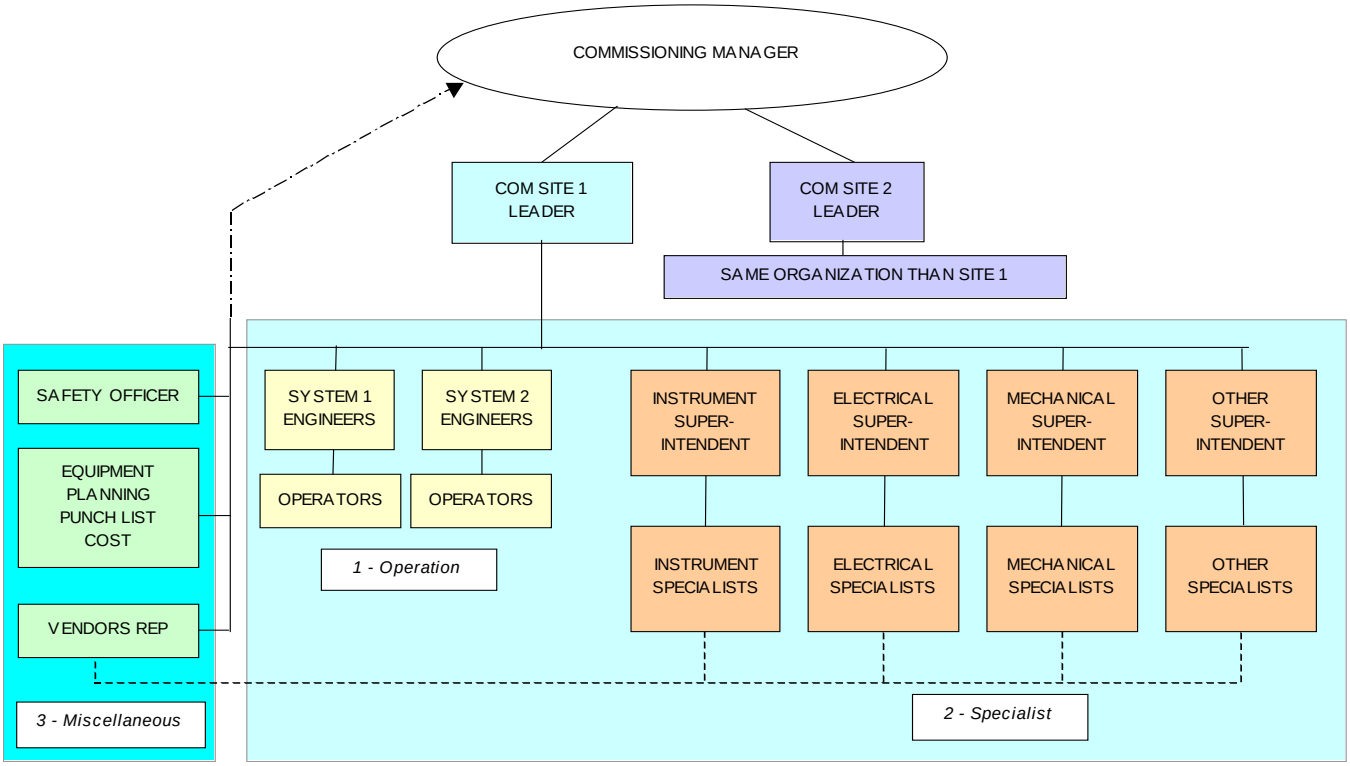
- Experienced organization, team
- Proven reliable procedures, methods and software
- Set up and develop an accurate and complete commissioning dossier (from RFC, though RFSU, to RFHO certificates)
- Effective and regular coordination with construction Team
- Participation in key factory acceptance tests (e.g. ICSS)

Commissioning within an EPCC contract

Typical responsibility breakdown

Project phase	Activity description	Actors Responsibilities			
		CONTRACTOR	COMPANY Construction Manager	COMPANY Commissioning Manager	COMPANY Operation Manager
Basic Engineering	Contract strategy, Pre-commissioning & Commissioning scope of work, Commissioning organization requirements		Define (with contract team)	Approve (Commissioning Exhibit)	
	Start-up sequence sub-system break down	Define (Basic Engineering CONTRACTOR)		Approve	
Detailed Engineering	Commissioning organization procedures	Define		Approve	
	Pre commissioning and Commissioning preparation (technical dossier) according to deliverables stated in the relevant specifications	Carry out		Approve	
Construction, Pre-commissioning and commissioning	Pre-commissioning Activates	Carry Cut	Control	Witness	
	Commissioning Activities *(in case of EPSC contract)*	Carry out *(Assist)*		Control *(Carry Out)*	Witness

Typical commissioning organization chart



Summary

- Preparation of the pre-commissioning and commissioning activities start very early in the project during Basic Engineering
- A well structured and systematic approach is necessary to handle pre-commissioning and commissioning activities
- In order to improve efficiency of the commissioning operations, the logic of yard activities is changed from a trade approach to a system approach when those activities begin
- Tools exist on the market to ensure that all systems and items are systematically checked prior to start up
- In EPCC contracts the responsibility for commissioning stays with the contractor but in general the future operation personnel attends those tests with a monitoring role



Collective knowledge

Collective knowledge

Foreword

- **Main objective**
  - Gather the experience gained throughout the project and transfer it to stakeholders

- **Main tools and means**
  - Procedures to close out the project
  - Return of experience

Project close out

- **Input**
  - **Documentation from each activity or sub-project**
- **Output**
  - **Close-out reports**
  - **As built documentation**
  - **Signed hand over certificates**
  - **Contractual obligations closure (financial and warranty claims)**

Management of collective knowledge

- **Performance feedback to Project Office**
  - Final report
  - Debriefing presentations
  - Lessons learned
    - Good practices to be repeated in future projects
    - Problem areas
  - Proposals for improvement of Company or Contractor referential
- **Debriefing between Company, contractors and vendors**
- **Debriefing with stakeholders including host country representatives**

Problem areas

Close out activities are essential but often face problems

- **Early demobilization of the teams**
  - Lack of key personnel
  - Incomplete files
- **Underestimation of the time needed to close out properly the project**
  - Cost issue?
- **Some of the activities (financial closure or warranty claims negotiations) might extend beyond project formal closure**
  - A small team to be maintained until all those activities are closed

Summary



- **Handover to the Operations team is complete when all certificates, as-built drawings and documentation are delivered**
- **A small project team should remain operational until all contractual and warranty claims are closed**
- **A debriefing of the project is essential to record positive and negative experience**
- **This feedback should be transferred to the knowledge database and internal documents/procedures updated**

Conclusion



Everthing is now set to start field operations